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Telephone Engineer

VOL. 31, No. 2 FEBRUARY, 1927 CHICAGO

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TELEPHONE EQUIPMENT

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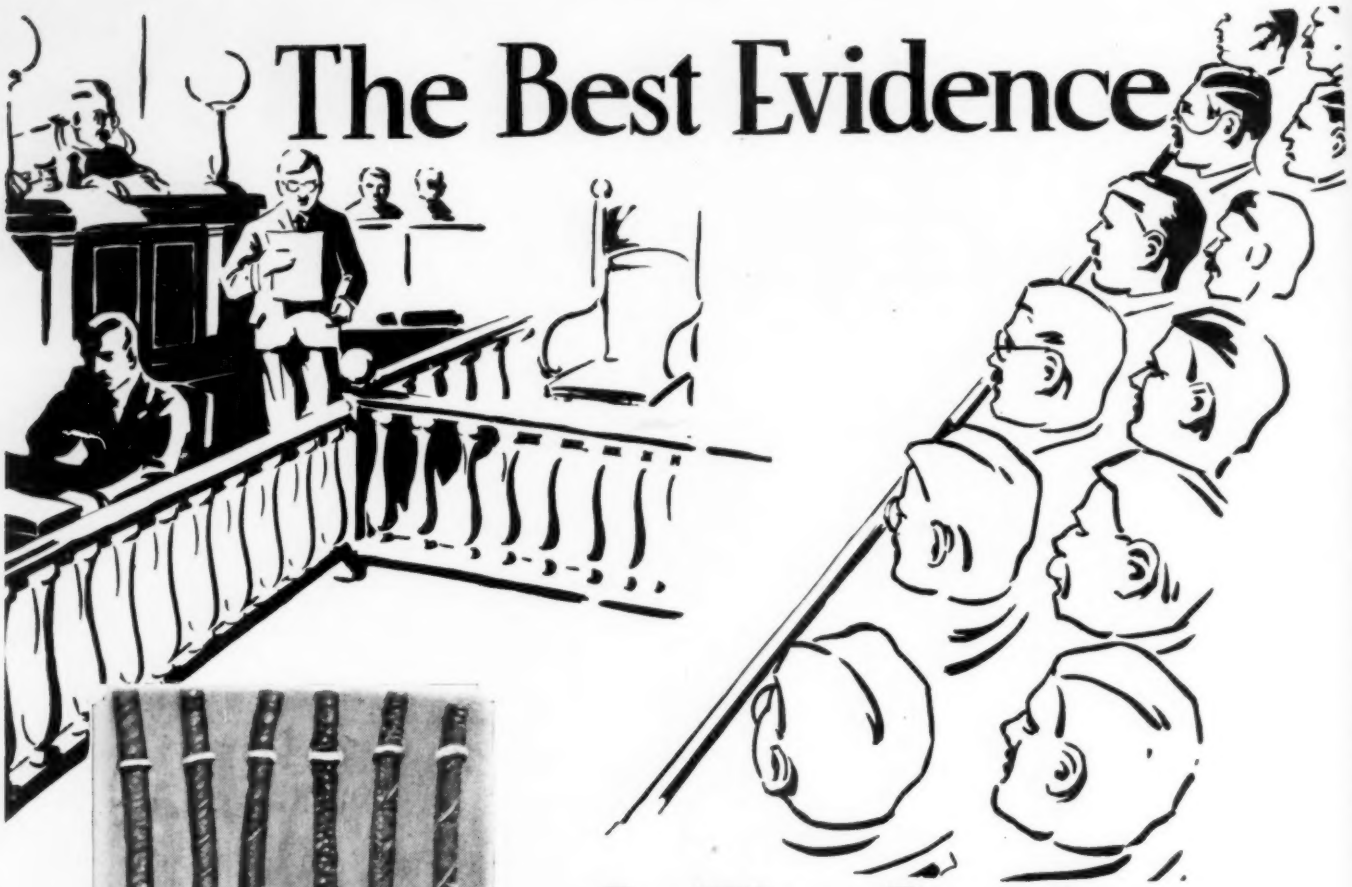

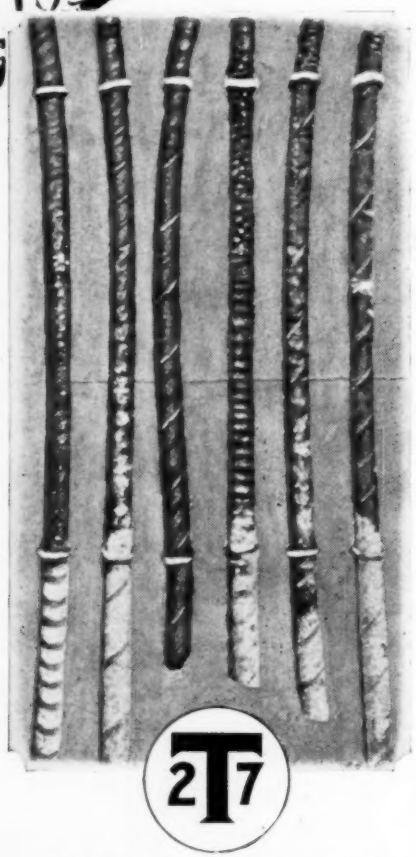

Is The Borings

Borings are the real "Inside Evidence" of the quality of Creosoted Materials. How long a Creosoted Pole will resist the ravages of decay or the destructive attack of termites and other agents which so quickly weaken and shorten the service life of untreated poles, depends upon the depth and uniformity of penetration of the creosoted oil secured during the treating process.

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Texas Creosoting Company
Main Office and Plant: Orange, Tex., U. S. A.

American Electric Company, Inc.
AGENTS
Chicago, Illinois

Texas "Black Beauty" Poles

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Telephone Engineer

Volume 31 FEBRUARY, 1927 Number 2

It's Still a Seller's Market

The situation for telephone properties continues to be a "seller's market." In other words, almost any kind of telephone plant can find a buyer at a price above what many owners honestly think the property is worth. It is a particularly favorable market for the man who is in the telephone business as a side line, for the man who wishes to retire from active business and for the man who having struggled along for years and, having made no conspicuous success in the industry, now is anxious to get out and let others take on the burden.

Being a seller's market it can not at the same time be a buyer's market. It is particularly unattractive to the man who now is satisfactorily situated in the business. While he may be able to sell at a good price if he sells he is faced with the necessity of buying at another location at a high price if he wishes to remain in the business. In the long run, he is likely to find that he is at a disadvantage for having made the change. If he is in the average position of having a plant and property considerably in excess of capital obligations, a sale and purchase of new property will change his situation to one where he is managing a property that is loaded to the limit with bonds, preferred stocks and other obligations.

In the first case, he can stand a recession of business without embarassment, while in the second, a slackening of business may place him in serious difficulties. In our judgment, the present is distinctly not a time for an owner of a well-paying going business to sell with the idea of purchasing elsewhere.

Why Not Monthly Payment of Association Dues?

At this time of year member companies are receiving their annual or semi-annual bills to cover assessments and pledges to national and state telephone associations. In most cases, the bills are OKd by executives and passed on for payment with little thought either to the amount paid or the service received. Six months after the payment is made, the executive in examining monthly income and expense statements can not determine in what month the payment was made.

As a general thing the amounts paid are so small in proportion to the revenue and expenses of the company that no monthly statement is thrown out of line by the payment of the entire amount in one month. As long as this condition exists, it would seem that no company is finding an undue burden in keeping up its association memberships.

It is our firm belief that every company, member or non-member of state and national associations, receives benefits of value several times the amount paid and it is likewise our belief that ably managed associations, adequately financed, could render much greater service if given the support needed. Certainly, no member company can complain of the burden unless it finds it must distribute the payments on a monthly basis and until association dues reach this level the associations are bound to be underfinanced and understaffed and consequently not in position to render a maximum of service.

"Other Line" Charges—Are They Overcharges?

Digest of public service commission decisions show frequent references to a type of charge made for long distance service that often is designated as an "other line" charge. In earlier days, before toll charges were built up on the present mileage and block systems, it sometimes was the custom to make a rate based on a charge from the originating point to a point where the message was switched to the lines of another company, plus an "other line" charge for the second company. No regular or orderly system was in use and the application of the charges often was discriminatory in character. Where such conditions have been brought to the attention of commissions, they invariably have

ruled that the "other line" charge should not be approved and that regularly scheduled rates should apply.

There are still many cases where charges of this type exist to which attention might be given by companies operating commercial toll systems. One form is the application of this charge on incoming calls but not on outgoing calls. In another form, this charge is applied to all outgoing calls by adding an extra charge for the local exchange to the regular toll charges. In still another form, the charge is made by charging the originating subscriber with the person-to-person rate, regardless of the class of call made. All of these forms are subject to local variations, and practically all of them result in some inequality or discrimination in charges.

It is probable that such practices as these are the outgrowth of earlier conditions and that very few of them are the result of a deliberate attempt to overcharge telephone patrons. In a majority of cases, where they are applied, the management is honest in thinking that the charge is applied solely for the purpose of obtaining for the local line, a proper share of the toll charges. Fairness to the general telephone-using public, however, requires that they be eliminated wherever they are applied in connection with the general schedule of a long distance rates, although there may be some purely local conditions where they properly may be left in force.

Many times, these conditions exist without the knowledge of the toll line companies and the toll line companies have been active in eliminating the cases that are found. In nearly every case where such charges still are in force, they can be eliminated by a fair settlement based on the allowance of a reasonable originating commission and a pro rate of mileage for the use of lines.

Good Neighbors With Good Rates Very Desirable

Not many days ago we asked a certain telephone manager how he was progressing with his plans for rehabilitation of a telephone exchange which he had purchasd a short time before. His problem was the ordinary one of building up a depreciated property to the point of giving reasonably good service and of establishing a rate schedule that would pay for the service rendered. He had anticipated some difficulty due to the apparent lack of progressiveness of the community and the long established habit of paying very low rates.

His answer was rather surprising in that he said that he had found very little difficulty. This he attributed to the fact that a similar situation had been worked out in a nearby town. In this neighboring town, a rehabilitation of the telephone system including a rate increase, ranging from 25 to 100 per cent, just had been worked out through co-operation of the citizens and the telephone management. On account of the close relations between the two towns, the citizens of the one were acquainted with the satisfaction which the subscribers of the other were deriving from service over a rejuvenated telephone system. As a result, the subscribers in a seemingly unprogressive place really were pleased at the prospect of improved service, even if the cost was to be increased. In fact, they looked upon the new owner as a sort of a Moses to lead them out of the telephonic wilderness.

The experience of this manager emphasizes what often has been said: That the public is willing to pay adequate rates if convinced that it will receive a fair return in the way of satisfactory service. It also emphasizes another point relative to the effect which a situation in one community may have upon that in another. Many a manager has found difficulties in securing an adequate rate because a neighboring exchange had put up with an inadequate rate for inferior service. In a similar way, many managers have found their difficult situations improved because a neighboring manager had found the way of securing increased rates for improved service.

Play Safe When Planning —Now Is Time

At this time of the year the engineering and construction forces are planning the program of extensions for the spring and summer season and working out the details of the cable plans. In the smaller and medium size exchanges where the same force is both engineering and construction, too frequently the details are planned as the work is going on. Too often, on account of lack of adequate study, the needs in certain sections are not correctly forecast and as a result it is found that cables have been planned on too limited a scale and are filled almost as soon as they are cut into service.

It does not take a great deal of time to survey a section of a city or town in which cable is to be erected and to make rather an accurate appraisal of the telephonic needs. In doing this, much trouble may later be avoided if adequate capacity is provided. In making cable layouts, it is a pretty safe rule to follow where in doubt as to the size of cable to be used, to select the larger and where in doubt as to whether a terminal should be provided, to provide the terminal. As one engineer expressed it: "Why put up cable unless you provide a sufficient number of terminals so that the lines can be connected to it."

Orient's Telephone Practice Has Unique Features

Bp RAY BLAIN

I had always heard that we in the United States had the best telephone service in the world but never gave the matter much thought until I had traveled for considerable extent outside the continental limits of my native land. I now realize that there are several good reasons including the telephone service why the U. S. A. is a good place to call home. It is true that there are so many things the average American does not realize or appreciate until after at least one severe attack of seasickness. I left San Francisco in October 1924, for Manila, Philippine Islands, where I spent two years wrestling with various tropical telephone problems. Then on one memorable afternoon I boarded the good ship President Jefferson and sailed for Hong Kong. These ships I consider are the best in the Pacific, are the envy of all rival shipping interests, and we should all feel proud that they fly the stars and stripes.

After forty-eight hours across the China sea we arrived at Hong Kong, which is a British port and is said to be one of the few free ports in the world. After being advised of the hotel rates, however, we were inclined to believe that this information was somewhat misleading. After riding in a rickasha, a sedan chair and the cable tram to the top of Victoria peak I located R. Emmit E. Farrel, engineer for the Hong Kong Telephone company, who was kind enough to conduct me through their central exchange.

The Hong Kong Telephone system was recently taken over by the present company, who have moved their business offices to the 4th floor of a modern office building and are making arrangements to use the entire 5th floor of the same building for the installation of a modern automatic exchange.

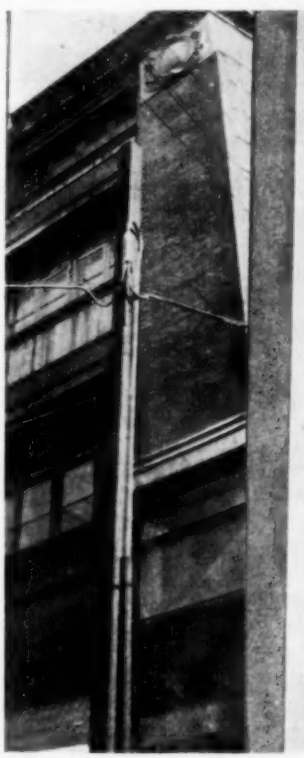
The present equipment is magneto of an European manufacture. The instruments in comparison to those we are accustomed, seem crude and cumbersome but appear to give fair service. The switchboard was crowded into a small room and operated by Chinese and Portuguese girls. Lamp signals were used, the line relays being rung up by the magneto at the sub-station. The line and cut-off relays were mounted as one unit in a tubular case. All adjustments on these relays were made by tension screws and it is never necessary to bend a spring. The main frame was similar to the kind we use except that the punchings on the connecting strips were so close together that soldering of the jumpers would be a difficult operation. The main frame and other terminal room apparatus like the switchboard was crowded into a very small space.

At the time I visited the exchange they were installing a few additional positions of switchboard to take care of the necessary increases until the automatic is placed in service. This work was all being performed by Chinese under the supervision of Mr. Farrel. The workmanship was all very good and the soldering as near perfect as any I have ever seen; in fact I doubt very much if even a W. E. Co. inspector could find any fault with it. In addition to the good soldering, frayed insulation was absent, the sewing of the cable form perfect, an extra precaution was taken by pushing a thin sheet of fibre in between the punchings of the jacks, with a row of holes drilled in the back edge about two inches from the connections and each wire tied firmly to it. I understand that very little trouble is ever experienced in a multiple built up in this manner.

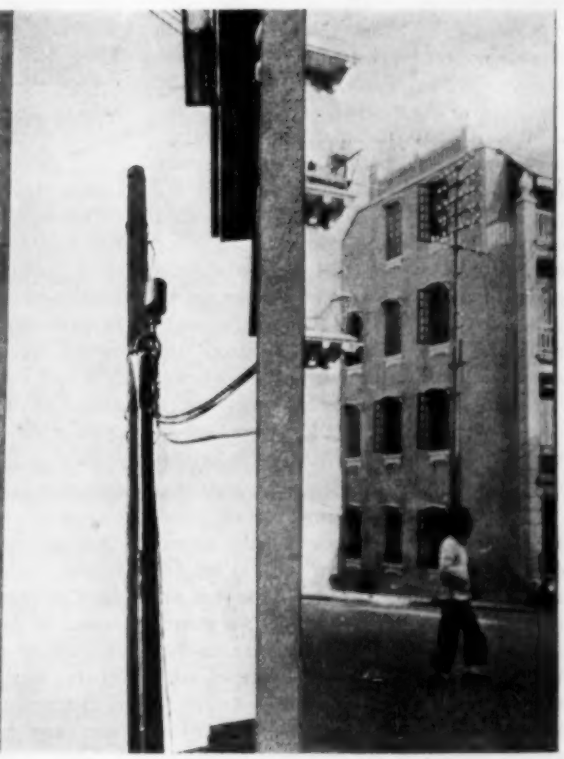
The outside plant seems to be in good condition and the greater part underground. Distribution was made from terminals installed on iron poles by iron wire tied in on white porcelain insulators. The terminals were connected to the cable by a patent pothead which was very neat and serviceable. The inside wiring consisted of a small lead covered pair fastened to the walls with a neat cleat. This arrangement was very neat and though expensive is no doubt very suitable for damp locations. All lighting circuits were run with the same type wire of a larger size. I wonder if there are not many locations in the states where a lead covered wire would not answer for the more expensive iron conduit and be just as serviceable.

Coolie Is Poor Splicer

I understand that the Chinese "coolie" is a very good workman when trained in any class of telephone work except cable splicing. He does not seem to be able



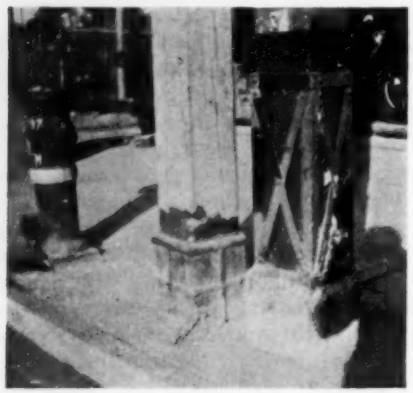
Aerial Splice Shanghai



Tunnel-shaped Cable Terminal Splice—Shanghai

Cable Terminal with White Porcelain Insulators—Hongkong

to get the trick of that. I saw one working on a splice in a small manhole in the middle of the sidewalk, with a large crowd of interested spectators standing around. The splice was about twelve inches thick and thirty long, with several cables out of each end. The coolie had one leg over the splice and was piling metal on one end with a ladle and flattening it out with a wiping cloth. After rolling the metal around until it got cold



Pole on left shows method used by light company. The pole on the right is a telephone company pole.

and the greater part had fallen off he would grab an odd looking blow torch and play the flame on the joint until about all metal was removed. In lieu of bar solder he would pour out metal on the sidewalk in strips and when it had cooled use with the blow torch to complete the joint.

A peculiarity about Hong Kong is that one never sees a beast of burden. Everything is either hauled or carried by coolies. It is a common sight to see ten or fifteen coolies pushing and pulling on a two-wheel cart loaded with sóme heavy material. All except heavier objects are carried suspended on a flexible pole laid on the shoulders of two coolies. They always take a trot and keep the load oscillating which in some manner seems to lighten the burden. The one in front will take a step and say "Whang," the other on the next step will answer "Wung." They are never quiet and I did not learn whether they keep time to the various noises or whether it is just done for pastime.

After exhausting everything of interest in Hong Kong we boarded the Japanese ship "Kashima Maru" and sailed for Shanghai, China. In due time we arrived and after being robbed by a money changer and a few tourist-wise coolies we finally arrived at a good hotel with all of our baggage. I did not get to visit the telephone exchange until after all my surplus money had been converted into Chinese embroideries and other novelties cheap in China but rare in the States. I realized how valuable the American dollar was when I found that it would buy $2.34 Mexican money which was the local currency in Shanghai. I made a $1.30 purchase in a small shop, gave a ten dollar note in payment, and received over ten dollars in change. I thought some mistake had been made until the salesman explained that he gave me several dollars small money in change and that small money was equal to $1.20 large money. In other words get small change for a dollar silver or a dollar bill and you receive $1.20 in the smaller coins.

Through the courtesy of Philip H. Cole, Engineer in Chief and General Manager, of the Shanghai Mutual Telephone Co., Ltd., Mr. Webb, one of the company's engineers, conducted me through the main exchange. The switchboard was very similar to a large manual board in the States. The operators were all Chinese boys and the supervisors white women. The Chinese boy operators all wore the Chinese dress which consists of a long flowing robe worn over the trousers.

The switchboard multiple was very high and the cord weights were all

Cableman working and policeman standing guard—Shanghai

equipped with double pulleys with a third pulley on the under side of the key shelf, the cord was then threaded through these pulleys like a rope through the sheaves of a block and falls. This arrangement permitted a cord length necessary to reach the highest multiple jacks. The call indicator positions (as they had some outlaying automatic exchanges), were typical of our own.

Due to limited time I did not have an opportunity to look over any of the main automatic exchanges but did have a "looksee" at a small Pax in the main exchange building. This equipment was of an European manufacture, very neat and compact, but in my opinion would be difficult to maintain. The units on some of this equipment are power driven from a continuously running shaft similar to our panel type machine switching.

This company had one stunt of testing and clearing cable trouble which probably has the distinction of being the only one just like it in the world. An electrical driven air compressor was installed in the basement near the cable entrance. This air is taken from the compressor through special apparatus to extract the moisture then through a pipe line to the cable well where it is distributed by smaller lateral pipes to the cables where it is connected to the sheath by an air-tight joint. When moisture shows up in a certain cable, the corresponding valve is opened in the small lateral pipe and air at a pressure of forty pounds is forced through the loose wrapped cable to the fault. This company maintain that if the air is applied when the fault is first noticed that serious failure can be avoided or rather delayed until permanent repairs can be made. Also in cases of slight moisture, resulting in low insulation, that the fault can be cleared by this treatment alone.

When a case of trouble is difficult to locate by the usual testing methods, the air is supplied to the defective cable and at some intermediate manhole clay is banked around the sheath in the duct line. Then by going to the next manhole and packing clay around the cable except for one small opening and applying soap suds to that; if the air blows soap bubbles it will indicate that the trouble is in that section. This arrangement reminded me of my early days in the smaller exchanges where the town joker had a lot of fun calling up certain old ladies and telling them that the telephone company was going to blow dust out of the cables and would they please cover up the telephone to prevent filling the house with dust. Nine times out of ten they would wrap up the telephone like a sore thumb.

Cable splicers in Shanghai were again different from anything I had ever seen before I found. They used sheet lead instead of lead sleeving and when three cables came out of one end and one out of the other, they cut and formed a sheet of lead to make a sleeve resembling a funnel. After cutting and forming the lead sleeve they would tin all edges with a soldering iron which was shaped like a hammer. This iron, when heated and passed over the edges with a piece of solder, left a nice tinned surface.

The city of Shanghai is all very near, and in some places below, sea level so that when working in a manhloe it is necessary to pump it out frequently to keep the water level below the open splice. I looked into one cable tent set up over a manhole and found two coolies with a deck of cards made in America and were playing a game similar to black-jack. They played right on without paying any attention to me and soon one had a large pile of copper coins and I guess the other walked home. I have known of similar things to happen in a cable tent in the States.

Unique Pole Setting

They have a stunt of setting poles in the down town section of the city which differs from anything I have ever seen before. First a concrete pier is constructed and set into the ground and extending above the surface twelve to eighteen inches. Embedded in this is a lattice work frame built from strap iron about the size of crossarm braces. The pole is set into this framework like a whip in a socket and wedged in with small pieces of strap iron. When a pole becomes defective it is an easy task to pull it out and set a new one in without disturbing the street surface. The poles used are all sawed and of uniform size. The power company in Shanghai has used a similar arrangement but the socket is of cast iron and set lower in the ground.

I understand that this system is not satisfactory and that they are changing to the arrangement used by the telephone company. The iron socket would likely cause a pole to rot but the lattice work being open to the circulation of air, prevents this difficulty. While this arrangement of setting poles has many advantages I do not believe it would be suitable where much strain was involved.

I noticed on new cable construction in Shanghai that cable rollers were set on the messenger about six feet apart for several blocks, the cable was then pulled in, the rings placed and the rollers removed. I do not know why they didn't first put the rings on and then pull the cable in through them without the use of rollers.

I also noticed two coolies testing for a cable pair in a usual primitive way. They had a local battery telephone of the hand set type, with battery connected externally spread out on the sidewalk and a pair of wires leading from it long enough to reach a cable terminal about twelve feet from the ground on the side of a building. One coolie held a long stepladder and the other took the pair of wires up the wall and connected it to a cable pair, came down, gave the generator a turn, spoke a few words, then went up and tried another. When I left he was still going up and down so that I am not sure that he ever found what he was looking for.

The telephone construction is uniform all over Shanghai but the light and power company lines differ in the various concessions, which are controlled by the different nationalities. For instance when you pass from the British into the French concession you will notice that the light wires leave the wooden poles and crossarms and run on concrete poles with the usual French goose neck bracket used in place of crossarms. I believe that the French have the right idea for a concrete pole, which is round with three concave sections which gives practically the same strength and much less weight than the usual solid square pole.

"Woo" Is Chinese Smith

There are more names of "Woo" in the Shanghai telephone directory than there are "Smiths" in the directory of any large city in the States.

There will be as many as forty "Woo Kung Kwan's" listed at as many different addresses, so that the listing would not be of much benefit unless one knew the address of the party desired. Terms used in these exchanges seem very peculiar, such as "Hang the receiver in the crutch," meaning the switchhook; "Line engaged" for line busy; "cut down" for disconnected, and "no reply" for don't answer. They never say that a line is

WOO-WOO 378

North	3843	Woo Chow Tinfoil Factory, c.890 E. Yuhang Road
Central	1780	Woo Chu Chan, 21 Hankow Road
Central	4455	Woo Chu Chan, 40 Soochow Road
Central	9013	Woo Chu Fong, Dr., 372 Hankow Road
West	2880	Woo Dah Tuck Kung Kwan, 4 R. Chapeal
West	4163	Woo Dau Liang, 811 Medhurst Road
West	2997	Woo Di Ching, 1083 Sinza Road
West	3940	Woo Doa Ling, 638 Ching Foo Li, Avenue Road
Central	426	Woo Doong Yung, 246 R. Kraetzer
Central	4646	Woo Fei, 210 Av. Joffre
West	4739	Woo Fong Zung, 18-20 Shanhaikwan Road
North	4863	Woo Foong, 667 Tsepoo Road
Central	4358	Woo Foong Bank, 55 Ningpo Road
Central	6162	Woo Foong Co., 78/80 R. de Lagrene
West	3308	Woo Foong Rice Co., 1092½ Sinza Road
Central	4310	Woo Foong Cotton Clothes Co., 54 Tientsin Road
East	50364	Woo Foong Rice Shop, 3.# 50-60 Muirhead Road
Central	7490	Woo Foong Steamship Co., Ltd., 35 Jinkee Road
Central	4353	Woo Foong Share Co., 177 Fokien Road
West	1069	Woo Fung Shu, 1 Love Lane
Central	9128	Woo Gie Kong, 109 R. Brodie A. Clarke
Central	7359	Woo Hai Kee, 12 R. de Montigny
Central	9403	Woo Heng Tsung, 684 Chekiang Road
West	2496	Woo Ho Weaving Fty., 31157 Avenue Road
Central	7913	Woo Jun Tsze, 15 R. Kraetzer
Central	4877	Woo Kai Ching, 30 Kuling Road
Central	5098	Woo Kee, 120 Chekiang Road
North	435	Woo Kee Garage, 4 N. Soochow Road
Central	2685	Woo Kee Native Bank, Tientsin Road
North	3674	Woo Kiang, 1629 N. Szechuen Road
Central	3329	Woo Kiang Chien, 425 Chekiang Road
North	3741	Woo Kiang Kee, 415 Ming Wai Li, E. Seward Road
Central	5915	Woo Kien Yuen, 73/5 R. Petit
West	503	Woo Kin, 140 Seymour Road
Central	7092	Woo King Ling, n.302 Yunnan Road
North	333	Woo King Shing Hong, n.a.301 Sawgin Road
North	4407	Woo Kong Rice Hong, 275 Tungchow Road
West	3393	Woo Kung Kwan, 609½ Burkill Road
West	2620	Woo Kung Kwan, 26 Edinburgh Road
West	221	Woo Kung Kwan, 221 Seymour Road
West	1963	Woo Kung Kwan, 4 Yates Road
West	1599	Woo Kung Kwan, 101 Jessfield Road
West	3924	Woo Kung Kwan, 120 Chengtu Road
North	2175	Woo Kung Kwan, 1092 Haining Road
West	3562	Woo Kung Kwan, 87 Bubbling Well Road
North	2706	Woo Kung Kwan, n.c.151 Sing Dong Kong Ka Loong
West	1539	Woo Kung Kwan, 1230 Avenue Road
Central	4620	Woo Kung Kwan, 424 Peking Road
North	2086	Woo Kung Kwan, r.s.164 Elgin Road
Central	8163	Woo Kung Kwan, 504 Thibet Road

Who Is the Right Woo?

grounded but that it is "earthed." They also refer to a grounded line as a line with earth return.

Just twenty-two hours by steamer from Shanghai and we arrive in Nagasaki, Japan. It was disappointing here as we were informed at quarantine that no passengers would be permitted to take cameras ashore, so therefore we did not get any pictures of telephonic interest. But riding in a rickasha looking for bargains in crystals and such, I noticed a small building which had several telephone cables entering it. I finally found a door leading into the terminal room and several neat looking Japanese men in attendance. They couldn't understand English but by making signs with both hands I finally made them understand that I wished to look through the exchange. The main frame was not much different from what we use except that there was a shoe testing arrangement on the horizontal connecting strips. The test desk looked peculiar and I could not make out what kind of tests they were conducting. The switchboard was neat and nothing unusual except the drop shutters which were about two inches square.

The switchboard was operated by Japanese girls, all dressed in reddish flannel uniform of the kimona style. When I left the terminal room and walked into the switchboard room I was followed by four Japanese men or rather boys who peeked over the back of the switchboard as if I were a great curiosity. When I noticed them they quickly ducked out of sight. There were several reels of cable in the yard back of the exchange that looked very much like cable from the States, but as there was no lettering on them except in Japanese I was unable to determine.

There was a new exchange building near the present office with a new main frame being installed and from all appearances the installation of automatic equipment is being contemplated. All telephones were evidently of Japanese manufacture and very large. I noticed one in a store that had a hinged cover on the transmitter which it was necessary to open before using the instrument. The outside construction including the cable splicing was very neat and indicated good workmanship. All poles were of a good size and looked like white cedar or pine. The tops of poles were all flat and had a tin similar to a pie pan turned upside down and nailed on the top. This arrangement may not be as cheap as a sawed roof but is no doubt more water proof. Most of the crossarms were made of angleiron with one angle set into the pole. These crossarms were not braced to the pole but if more than one arm was on the same pole they were braced together at each end. All wire in the down town section of the city was about No. 16 gauge and appeared to be copper or probably copper clad steel. Some twisted pair wire was used and looked peculiar as one wire was all red and the other black.

I took a ride over the mountain to "Moji" in a Buick automobile and noticed that a very good telephone line paralleled the road all the way. The stop over in Japan was all too short and it was soon time to board the ship and sail for San Francisco. On this trip we were nineteen days out of sight of land, which is a long time, especially for one who was reared in the central states. But it was worth it all to get back to the land of the free where men are men and women are Governors.

Studying the Details of Telephone Work

By E. R. COLLINS

Wire Chief, Manitoba Telephone System, Brandon, Manitoba, Canada

In the telephone industry, there are comparatively few men who have had the advantage of a university training. To many men there is a great difficulty in reading the average text book, on account of the large amount of technical data. There is also the human weakness, which interferes with a careful study of a text book, that is, "the tendency to read in chunks," and not to follow in any carefully planned method of study.

It is true that much is learned by the men in their actual working with telephone apparatus, but it is also surprising how many men there are who can tell you all about the proper way to connect up a telephone, or an intercommunicating system of a certain type, yet if confronted with a new piece of apparatus, would be absolutely at sea. The reason is that they have learned by being shown that a certain wire of a certain color goes to a certain place, but why it is put there is a different question.

A thorough understanding of the theory, and the actual function of each piece of apparatus, entering into the system, is necessary, if a man is going to be able to get away from doing things blindly. There are certain groups of equipment, which if out of order, will affect many subscribers. In actual practice the man who knows what to do, and how to do it quickly, is the man who will be most in demand to fill the positions of responsibility.

In order that those men who are anxious to learn, but find difficulty in following through, may be able to increase their knowledge of the workings of the system, the writer will endeavor in this series of articles to show as simply as possible, the different parts played by each piece of apparatus, and some of the simplest ways of maintaining service with the equipment in use. This is best accomplished if some one such as Wire Chief or Plant Chief, or any one who feels qualified to do so, will form a class and with them study the theory and practice of the telephone system.

Forming a Class

There is no higher honor that could be conferred on any man than to have had the privilege of training one or more men to do their work better and more intelligently. There is no more interesting study than the mysteries of the telephone and its equipment. It is also an interesting fact that the man who will do this will himself gain much knowledge and strength of character by conducting a class in the interest of his fellow employes, especially when this is done with the unselfish desire of helping them. Now that is some sermon I have preached so far, but never mind as long as you get my meaning.

The class should not be too large, not over a dozen at the most, as much individual work will be necessary to do it right. An enrollment fee of at least $1 should be charged to give the student something at stake. He will then feel that he is going to get something out of it.

The money raised can be used to buy a blackboard, brush, chalk, and other incidental material. If the expenses involved are more than you have collected, tell the boys and they will "come across" gladly. A blackboard about 4x8 foot should be secured if possible. The space available to mount the board will determine the size. Possibly one that has been taken from one of the schools can be obtained from the local school board.

Each student should have a notebook, preferably the loose-leaf style, and have them uniform. Also insist that each man take notes of the work. It will be of great value to him as he progresses in his work. It might be an incentive to have the local manager offer a prize for the best completed notebook. Try it, anyway.

Classes should be held at least once a week and should not be over two hours' duration. From 7 p. m. to 9 p. m. are often convenient hours. Classes should begin promptly, even if all the boys are there or not. If interest seems to lag in any class, better close it and go home, or you will spoil the attendance for the next one.

The teacher must be prepared for some hard work. He must first prepare his text carefully. Then he must have his experimental work well planned. Always run the experiments through alone before the class is started, as nothing will lose interest as quickly as an experiment that is a "dud."

After the experimental work is done and the explanations completed, call for a discussion. And look for some funny questions. You will find out that your knowledge of the subject of telephony is as full of holes as a sieve, when the questions start to come in. Now, if you don't know the answer, be careful. Don't lie about it, but own up to it, as you are not expected to be infallible. Promise to find out the answer for the next class, make a note of it and don't forget to have the answer ready.

Most of the equipment for experiments can be found in the average telephone exchange. The rack room is usually a good room for the class. Additional equipment can sometimes be borrowed from the local high school or technical school, or the class might even be held in one of the school class rooms if arrangements can be made. The writer conducted one class in the laboratory of a local college where some of the college students were members of the class for the study of the telephone.

The information given in the following articles must of necessity merely scratch the surface but it will give an idea of what is underneath, and then it is up to the individual scratcher to dig in if he wants to. Our first consideration will be with the phenomena of sound.

Sound

The phenomena of sound is the linking up of the human brain with disturbances or vibrations in the surrounding air. The human ear acts as the device for translating vibration into human intelligence. The ear is a complicated device composed of an outer collecting construction which converges the sound into a small channel. This conveys the vibration to the inner ear where a membrane is stretched across the end of the passage. On the inner side of this membrane, or diaphragm as we call it, is attached a series of bones which, through a system of levers, operates on a stirrup and anvil and through a delicate arrangement of nerves. These in turn convey to the brain the effect of the vibration which we call sound.

It is with the operation of this diaphragm that we are chiefly interested. To get an idea of how it works, obtain the cardboard case of a dry cell. Invert it over a telephone receiver which is connected to a working telephone. Place some sand in a piece of cheesecloth and sprinkle evenly over the horizontal bottom of the battery case. Now turn the howler on the telephone, or have someone speak into the transmitter with

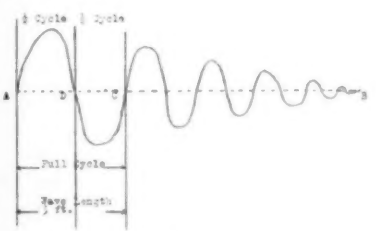
different sounds. Observe the motion of the sand.

The motion of the cardboard is up and down with the greatest motion at the center, because the sand will be observed to dance violently at the center and will gradually crowd to the outer edges which, being held rigid, cannot vibrate. You can see, therefore, why the bone mechanism of the ear is connected at the center of the diaphragm. Sometimes the diaphragm of the ear becomes hardened and will not respond to air waves, and we say the person possessing the ear is deaf.

Sound is caused by vibrations in air, water or solids. The actual effect on the human ear is the result of vibration in the ear chamber, at least of the air present. It is possible also to hear through the medium of the teeth and other bones of the body transferring the vibration to the ear bones. For instance, some deaf persons use a large piece of hard rubber like an ordinary fan, and by biting on the rubber with the teeth can hear what is being said, the hard rubber in this case acting as the diaphragm, transferring the energy to the bones through the teeth.

How the sound travels through the air can be shown by taking a piece of heavy rope secured solid at one end and held in the hand of the experimenter at the other. (Draw on the blackboard sketch No. 1.)

Fig. 1



(*Fig.* 1)

Quickly wave the rope up and down several times with an evenly timed motion. The rope will form in waves, large at the experimenter's end, *A*, and gradually diminishing to the solid end, *B*. Sound travels through air in much the same manner, only instead of a single line such as the rope, it goes in all directions. Where a person is speaking the sound will radiate strongest directly away from the speaker's mouth.

The resistance of the air to motion will gradually dampen the wave set up by a voice, much the same as the solid end of the rope dampens the wave set up. Referring to Fig. 1, from *A* to *C* we call a complete cycle. From *A* to *D* is one-half cycle, and from *D* to *C* the other half cycle. Now, if the rope is moved up and down and down and up, as from *A* to *D* to *C*, five times in a second, we would say that the rope was vibrating at a frequency of 5 cycles per second. This can be abbreviated and be shown thus: 5~

The sign is merely a miniature figure of *A-B-C* in Fig. 1.

Referring to Fig. 1 again, if the distance of the wave from *A* to *C* is 3 feet we would call it a wave length of 3 feet. Measure your rope and see what the wave length is. In radio we speak of the wave length in meters, which is about the same thing as saying so many yards.

Repeat this experiment with different lengths and weights of ropes, and wave at the speed that will give the greatest wave to the rope. It will be noticed that each piece has a speed or frequency at which it will wave the best. We call this the natural frequency period of so many cycles per second.

Experiment No. 2

Now borrow a guitar and observe that the stem is laid out in different sections. If the strings are pressed down against any section the vibrating length of the string is from the main support to that section. Try the effect of the sound of a single string for different lengths. It is noticed that shortening of the string gives different tones, also different tensions put on by the adjusting screw will give different tones. Now strike two or more strings at different lengths and note that while each string has its own particular tone, the combination of them all will be a harmony of all, but appears to be a single sound, which is more pleasing to the ear than the single string.

The human voice is equipped to produce harmonious sounds. The larnyx, or voice box, is a harp-like arrangement of many different lengths of tendons secured to an arch which has the power of changing the tension of the tendons. Thus, by muscular movement the result of training, these tendons can be varied in tension at will to produce the harmonious sounds of speaking and singing as air from the lungs is forced past them. The teeth and lips also have an important part in the formation of speech, which we will not undertake to discuss here.

The human voice has a large range of vibration periods, varying from 87 cycles per second to 2,000 cycles per second in the average voice, and going even as high as 30,000 cycles per second in some voices.

The human ear can respond to a range of from 30 cycles per second to 32,000 cycles per second. It is also known that some ears can detect sounds that are not perceptible to others. This appears to be not so much a matter of ear construction as the training of the brain to detect the sound effect.

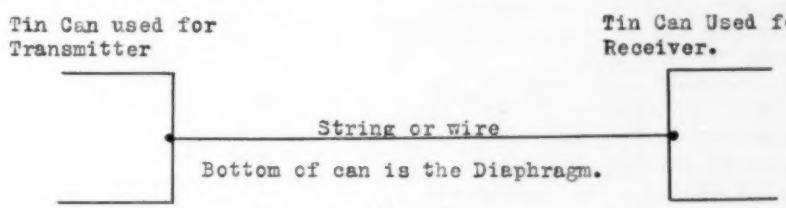
Sound Transmission

The word "telephone" is taken from two Greek words, "tele" (at a distance) and "phone" (a sound). When we speak to one another at close range we are really telephoning, although we seldom speak of it as such. In this case the air between us is the medium used to transfer the vibration set up in the larnyx of the speaker to the brain of the listener. The distance over which this can be done is comparatively short.

The ordinary speaking tube used in stores, etc., simply confines the energy of the vibration in a definite direction and is in effect an extension of the speaker's mouth and lips. This permits converse at slightly greater distances.

In Fig. 2 is shown the scheme of a toy arrangement which, instead of using the air as the medium, uses a string or wire.

Get two baking-powder tins, punch a hole in the center of the bottom of each and secure a string with a knot through the bottom of each tin. Have one speak into the one tin and one listen at the other, as far apart as the string will allow when stretched tight. In this case the sound from the speaker causes the air to vibrate, carrying the vibration to the bottom of the can, which we will call the diaphragm. The diaphragm moving in and out varies the tension of the string which in turn will vary the tension of the diaphragm at the listener's end, in turn causing the air to vibrate and transfer this vibration to the listener's ear and thence to the brain.



(*Fig.* 2)

Such a system was in use at Sault Ste. Marie, Mich., many years ago. The diaphragm was of parchment stretched over a wooden ring, and a steel wire was stretched to the central tower. The operator at central was signalled by using a small hammer to rap on the parchment. In this system the operator had to repeat the message to the other called party. Such a system, of course, is only of passing interest to us now.

To enable human intelligence to be transmitted over greater distances re-

quires something of greater range and more flexible. So a combination of mechanical and electrical apparatus has been developed to accomplish this, until today the world seems to hold no bounds to the disatnce over which men may talk. In fact, some ambitious experimenters have dreams of some day talking with mars, if there is anyone there to talk to. Something like the two men in the trenches, when one said, "If we had some bacon we could have some bacon and eggs, if we had the eggs."

(To be continued)

Ladd Named President by Arkansas Association

Little Rock, Ark.—E. P. Ladd of Star City was named to succeed J. E. Armstrong of Russellville at the fourteenth annual convention of the Arkansas Telephone association, held at the Hotel Marion here, January 17 and 18. Other officers elected: vice-president, E. B. Rhodes, Fordyce; secretary-treasurer, Conrad Elskens, Jr., Paris; and chairman of the board of directors, S. A. Land, Little Rock.

W. M. Graham, manager of the Clarendon Telephone Co., Clarendon, responded to the address of welcome. Then followed the reports of officers and committees, the presentation of guests and new members and the annual address of President Armstrong.

On the opening session program were talks by E. B. Rhodes of Fordyce on "Efficient and Economical Methods of Operation of Telephone Properties," and by L. M. Emerson, of Prescott, on "Value of a Telephone Directory With or Without Advertising." The program of the first afternoon session included talks by W. M. Graham of Clarendon on "Importance of Efficient Accounting"; C. C. Watson, Monette, on "To What Extent Should Our Policy Go in Forcing Collections of Delinquent Accounts"; E. G. Greber, Little Rock, on "Facts on Small Telephone Plants," and E. P. Ladd, Star City, on "Suggested Methods to Secure More Members and Interest in the Arkansas Telephone Association."

Discussions regarding methods of training employes in order to secure the best possible results for the benefit of the public featured the meeting Tuesday morning.

Those who spoke at this meeting and their topics were: "Importance of Trained Operators and Other Employes of a Telephone Exchange," by L. M. Loring, division traffic superintendent of the Southwestern Bell Telephone company of Little Rock; "Best Method of Accounting for Depreciation in Property," by H. J. Elskens, Jr., of the Citizens Telephone company of Paris; "Importance of Retaining Good Will and Confidence of the Public, Especially Our Subscribers," by W. J. Moore, president and manager of the Boone County Telephone company of Harrison; "Procedure and Methods in Making Request of a City Council for Authority to Increase Exchange Service Rates," by R. E. Norris, secretary and manager of the Berryville Telephone company of Berryville.

Among those who spoke Tuesday afternoon were: George W. Walker, owner and manager of the Sheridan Telephone Co.; J. E. Boatright, manager of the Crossett Mercantile Co.; F. B. Sprague, owner of the Corning Telephone Co.; H. L. Bernard, owner and manager of the Foreman Telephone Co., and President Armstrong.

Showing Routes of the Three Transcontinental Lines
The northern line, from Chicago to Seattle, was opened January 17. The original transcontinental, from Chicago to San Francisco, was opened in 1915.
The southern route, from New Orleans to Los Angeles, was put into service in 1922.

Third Transcontinental Line Is Opened

New York City.—Speaking through the same instrument that ten days previously opened trans-Atlantic telephone service, Walter S. Gifford, president of the American T. and T. Company on January 17 opened the northern transcontinental line in conversation with officials of the Pacific T. and T. company.

Three transcontinental telephone lines now span the American continent. The first was opened for service January 25, 1915. Gradually the range of transmission had increased, following the first long distance conversation on record, which occurred on October 9, 1876, between Boston and Cambridge, a distance of two miles. By 1880 the range of conversation had extended a distance of forty-five miles from Boston to Providence, and in 1884, New York and Boston were connected. Then the westward march began. Buffalo was reached in 1889, Chicago in 1892, Denver in 1911, and Salt Lake City in 1913. Finally in 1915, the Atlantic Coast talked with the Pacific for the first time. The transcontinental air mail practically follows this pioneer telephone line, not only from Chicago to San Francisco, but between New York and Chicago. The southern transcontinental line runs from New Orleans to El Paso, connecting at New Orleans with points on the Atlantic Coast, and at El Paso with Los Angeles and points on the Pacific.

The new northern route extends from Chicago to Minneapolis, Fargo, Bismarck, Billings, Helena, Spokane and Seattle. About one-third of the line from Chicago and Seattle lies within the state of Montana, where, after following the Yellowstone River for 350 miles, it goes over the Bozeman Pass at an elevation of 5,572 feet. Over that transcontinental divide at McDonald Pass it reaches an elevation of 6,359 feet.

The line is built to withstand snow storms and temperatures of fifty degrees below zero at some points and one hundred degrees above at others. The copper wires are of No. 8 gauge, weighing 435 pounds to the mile. Repeater stations are located at ten points between Chicago and Seattle.

Hold Biggest, Livest Meeting in Minnesota Association History

St. Paul, Minn.—Minnesota's biggest convention was held here with a registration exceeding 360. The St. Francis Hotel, during the convention of January 25-27, saw a state meeting that was a model, not only in the character of the program, but in the attendance and interest at the sessions. Members of the association and exhibitors were unanimous in pronouncing the meeting a record-breaker from every angle.

P. M. Ferguson, Mankato, was elected to succeed E. P. Wright, Alexandria, as president. Others on the new slate are Irving Todd, Hastings, vice-president, and J. C. Crowley, Jr., St. Paul, who was re-elected secretary-treasurer. Directors elected A. H. Dreyer, Starbuck; G. M. Dwelle, Lake City; P. M. Ferguson, Mankato; Jay Greaves, Glencoe; H. F. Lueders, Norwood; C. L. Scofield, Benson; Max Simon, Fulda; Irving Todd, Hastings; E. P. Wright, Alexandria; Thomas Vollom, Erskine.

In President Ferguson's address he lamented the fact that the companies the association could serve to the companies' greatest and most direct profit, too frequently were those who were not association members. He touched on the work done by the association helping member companies in rate cases, interference, disputes about territory, accounting, financing and various other matters. He went into detail regarding the association's services in getting immediate help in rate appeals for member companies, and also detailed the association's efforts in getting its members set right on accounting practice.

Preventive maintenance also was stressed in the presidential address. Mr. Ferguson cited cases in his own company's work where this practice had paid well. There was a review of the 17 district conferences held during the last year presented, and particular emphasis was placed on the value of the round table sessions at these conferences. Mr. Ferguson lauded the work of the association's secretary-treasurer, J. C. Crowley, Jr.

Arthur E. Nelson, former mayor of St. Paul, spoke on the work of "Northwest Associated" in helping the farmers and business men of the northwest territory.

Opening the specific end of the program came A. L. Ericson, manager of the Hector Telephone Company, who spoke on "Testing for Faults on Rural and Exchange Lines and Improvements Made Thereby." Mr. Ericson illustrated his address with a number of charts and showed samples of poor wire joints and other sources of trouble.

"Minnie, the Operator," a skit presented by employes of the Northwestern Bell Telephone Company, gave the conventioneers a laughable and significant contrast between the slipshod method of running some small plants and the proper way in which they should be conducted.

C. B. Randall, vice-president and general counsel of the Tri-State, spoke Wednesday morning on the recent order of the Interstate Commerce Commission relative to telephone company depreciation charges, and especially urged on his hearers use of the depreciation reserve. An illuminating paper on "Association Services Rendered to Our Company," prepared by P. E. Johnson, Northfield, secretary of the Webster County Farmers' Telephone Company, was read in Mr. Johnson's absence by Secretary Crowley. This address was replete with specific examples of the association's valuable cooperation in bringing one of its member companies around to the status of a modern well-operated enterprise.

Insurance for telephone companies was the subject of the remarks made by J. E. Scanlan of the Michaud Insurance Agency, St. Paul. Mr. Scanlan cleared away some of the misunderstandings concerning insurance with particular reference to automobile insurance. The program was lightened by the introduction of Rev. Roy L. Smith, pastor of the Simpson Methodist Episcopal Church of St. Paul, who spoke in an entertaining way on some "Wild Notions I Have Met." The St. Paul pastor is well known for his newspaper syndicate material and stirred up the meeting with one of the best addresses, not of a strictly business character, that has been made before a telephone meeting recently.

The inspiration of a general character that the divine handed out was good advance material for the specific inspiration in the address delivered by President MacKinnon of the national Independent body. He told of the trials of of the Independent pioneers, among them Richard Valentine of Janesville, Wis., and J. L. W. Zietlow, the South Dakota pioneer, both of whom now have passed to their rewards. He related a conversation he had engaged in with Theodore N. Vail, in which the late Bell chief said to Mr. MacKinnon, "we both must see to it that no one who has invested his money in the telephone business will lose thereby." "That," Mr. MacKinnon stated, "has been the underlying principle in the elimination of duplication since." He warned against outsiders coming into the business and introducing the element of speculation, and reminded his hearers that the telephone company owner when he sells is turning over a trust that has been his for years and should not be carelessly handed to others who might not be capable of handling this responsibility. If a telephone man wants to sell, let him sell to another telephone man, advised President MacKinnon.

The concluding session was given to a round table session, during which H. P. Sentman, Fairmont, spoke on recovery of plant; Max Simon, Fulda, on work reports, and J. W. Howatt, supervisor of telephones for the Minnesota commission, and A. C. Cragg, general auditor of the Tri-State, gave their ideas on recovery of plant and accounting charges that should be made.

As the semi-windup address Secretary-Treasurer Crowley talked on "Values" and related cases where poor accounting was responsible for telephone companies being denied proper profits. Charles C. Deering, secretary-treasurer of the U. S. I. T. A., told the Minnesota men of the success the correspondence toll operating course is having and urged managers to enroll their operators in the course.

Minnesota's annual banquet and dance was the largest ever held by the association. Almost 500 people packed in the banquet rooms, looked over the program of singing and dancing numbers, and "stepped their stuff" during the Wednesday evening festivities.

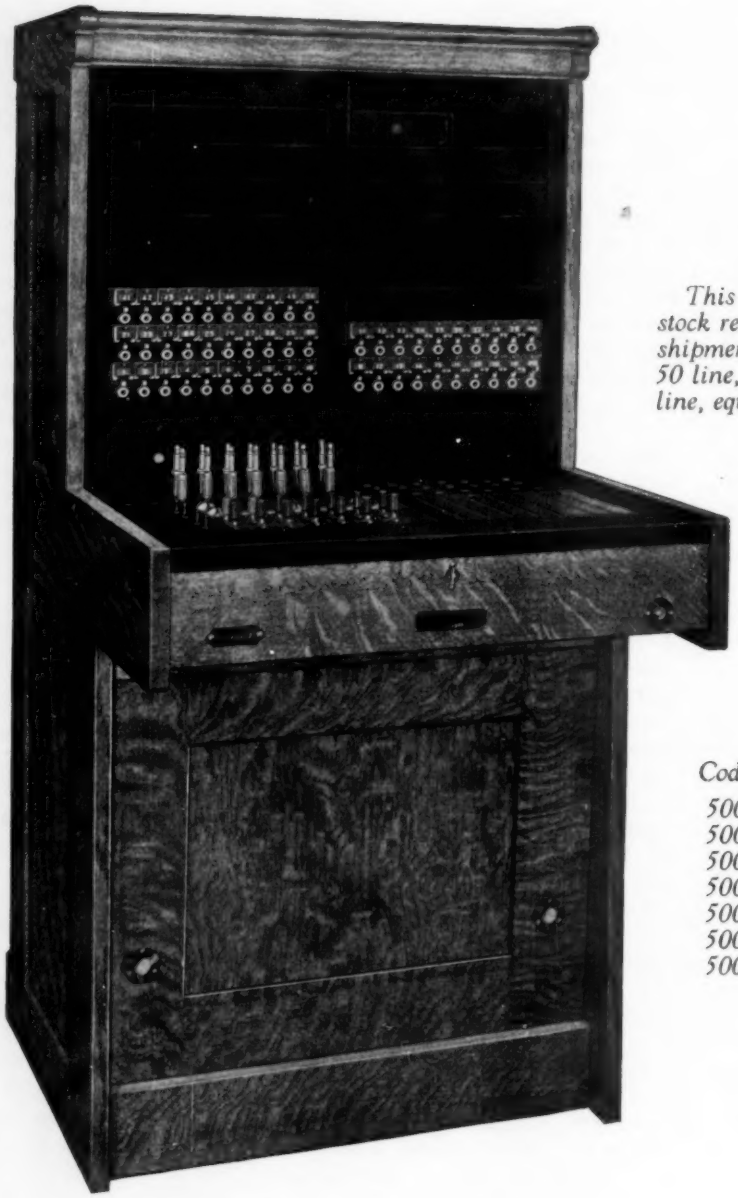
Western Electric Forms New Research Company

New York City.—The Western Electric company has announced the organization of the Electrical Research Products, Inc., of Wilmington, Del., a subsidiary corporation formed to take over that portion of Western Electric business which is not related to the manufacture and distribution of telephone apparatus and supplies for the Bell System. All of the new corporation's stock is owned by the Western Electric company.

The field of the Electrical Research Products, Inc., will include the commercial development of electrical devices and inventions controlled by the parent company and not suitable for distribution through the Graybar Electric company, its subsidiary operating in the distribution of electrical supplies.

The Bell system's continued expansion imposes on Western Electric an increasing responsibility for equipment and supplies, and it is to enable the Western Electric organization to devote itself primarily to this service that the new company has been formed to carry on operations relating to the by-products.

J. E. Otterson, general commercial manager of Western Electric, becomes general manager of Electrical Research Products, Inc. His office will be at 195 Broadway.



Magnet
Reache

This board is carried in stock ready for immediate shipment in three sizes, 50 line, 100 line, and 150 line, equipped as follows:

Code No.	Lines Wired	Lines Equipped	Cord Eq Wired—E
5001-A	50	30	15
5001-B	50	50	15
5001-F	100	60	15
5001-C	100	80	15
5001-D	100	100	15
5001-G	150	100	15
5001-E	150	120	15

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Telephone Equipment and Supplies

How to Read Telephone Circuit Diagrams

By DAVID S. HULFISH

Copyright, 1927

All of our written languages began with picture writing. The transformation of language to symbols, called letters, came principally through the laziness of the writing person, who continually would simplify the more complex forms. At the same time there came a benefit to the reader, since the simpler symbols were more easily read.

The telephone circuit diagram has a language of its own. That it is worthy of consideration as a language in itself, is a statement quite in harmony with the development of the variant written languages of the peoples of the world.

It is a simple language when approached in a spirit of reverence. It is quickly mastered when intelligently and carefully studied. But to him who rushes unprepared into the task of deciphering an intricate circuit drawing, the barbed-wire entanglements of a military defense thereafter should have no terrors.

Confusion to the reader may result from a lack of skill on the part of the maker of the diagram. One unfamiliar with accepted symbols may originate symbols unlike anything theretofore used. In such a case, the meaning of the new symbols, and of the complete diagram, may be deciphered through a knowledge of the principles by which accepted symbols have been developed.

The rule may be recited that a symbol is a picture simplified to make it easier to draw.

This is not a rule to be taken without exception, but it is almost universally true for symbols representing detached units of apparatus. The modifications of the original pictures sometimes obscure the original greatly, and the viewpoints which may be taken for a single unit of apparatus are numerous.

The general rule for making a telephone circuit diagram is to locate upon the page a symbol for each of the units of apparatus, and then to connect the conducting parts of those symbols with lines representing conductors or wires. The location of the symbols upon the page is in general immaterial, since the electrical relation usually is shown rather than the mechanical relation; this, however, leads to a subject for later consideration, viz.: the combination of mechanical details with the electrical details of a circuit diagram.

Those telephone circuit diagrams which are confined substantially to electrical details may be divided into two classes.

Wiring Diagrams

First for consideration is that class of circuit diagrams known as "wiring diagrams." Diagrams of this class are intended primarily for use in enabling workmen to connect the wires running between the different parts when the telephone system or apparatus is being constructed. In such a diagram the various mechanical parts necessarily are shown in sufficient detail to enable the workman to identify the different terminals of each part upon the part itself, merely by reference to the wiring diagram; the workman then proceeding to connect the indicated terminals by wires as shown in the wiring diagram, thus completing the structure. Such diagrams, however, usually show each of the parts of apparatus in such degree of detail as to enable the operation of each part to be noted, and thus the entire circuit of the structure may be learned from the wiring diagram and the structure as a whole may be understood from it.

In addition to service for the construction of the telephone apparatus, the wiring diagram is a necessity in the operation and maintenance of the apparatus, enabling faults to be located and repairs to be made with facility.

It would seem, therefore, that the wiring diagram fulfills all of the requirements of any telephone circuit diagram so far as electrical conditions are concerned, since it enables the apparatus to be constructed, maintained and understood thoroughly. Its single fault is that it is complex. For this reason alone a second class of circuit diagrams exists.

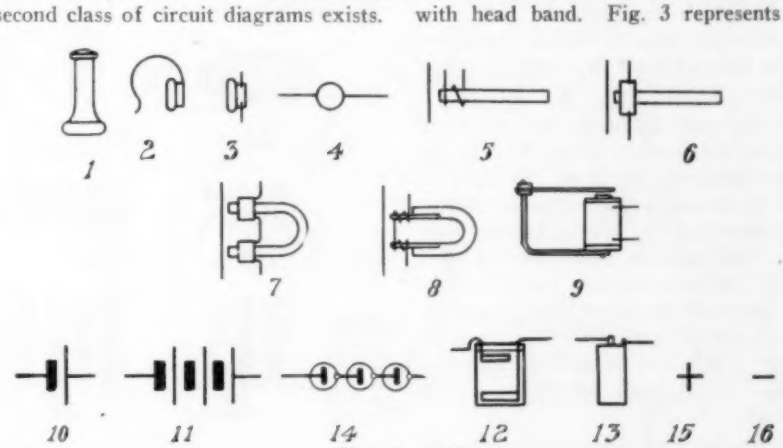
The second class comprises simplified circuit diagrams, and these are known as "simplified," "schematic" or "skeleton" diagrams. They set forth the electrical details only, and show those as simply as possible. In the symbols the greatest simplification is desirable, and the lines connecting the various parts are to be interpreted as representing electrical conductors rather than wires in any part of the system. A single line upon a "schematic" diagram may correspond to several wires in the wiring diagram and in the physical apparatus, or merely to a conducting structural part in the apparatus. The object of the skeleton diagram is to offer a synopsis of the detailed wiring diagram in order that the nature of the system, its object and its means of accomplishment may be grasped readily by a reader to whom the entire circuit matter is new.

It is customary to accompany a complex detailed circuit or wiring diagram by a small skeleton diagram of the same subject. A very good conception of the relation of two such diagrams, when thus used jointly, is to regard the detailed diagram as a book of information to which the skeleton diagram is the index, or table of contents.

The first thing required of the reader is the ability to recognize the more common pieces of apparatus by their symbols. They will be taken up in order.

Receiver Symbols

The telephone receiver is built into containing cases of distinctive shapes, and representations of receiver cases are used as symbols. The types most commonly used are those of Fig. 1 and Fig. 2. The Fig. 2 represents an operator's receiver with head band. Fig. 3 represents the



Figs. 1 *to* 16

"watch case" receiver. Fig. 4 represents the face view of any receiver; it is a symbol which requires "context" or association with other symbols to enable its meaning to be determined; but when we find a transmitter symbol, an induction coil symbol, and the symbol of Fig. 4, properly associated with connecting wires, it will be clear from the association that the symbol of Fig. 4 represents a receiver.

The original telephone, which was used both as transmitter and receiver, was substantially a rod of iron with a wire wound around it a few times, in combination with a disc of sheet iron held over the end of the rod but not touching it. All of these electrical features are pictured in the simple symbol of Fig. 5, which is a common symbol for any receiver or for a magneto transmitter. Fig. 6 shows a modification, a spool being shown instead of the separate turns of wire.

In Fig. 7 and Fig. 8 the bipolar receiver is shown. The symbol of Fig. 9, no longer used, also represents a receiver or magneto transmitter, and it is of interest as being the symbol used by the inventor, Alexander Graham Bell, in the first telephone patent ever issued.

In this set of symbols for the receiver, Fig. 4, should be noted as being the ultimate reduction of the pictorial idea, and Fig. 5 as being the ultimate reduction of the diagram of vital parts, both of these symbols being reduced to a point of great simplicity and ease of drawing. Fig. 1 is the preferable symbol.

The accepted symbol for a battery cell is that shown in Fig. 10, and no symbol is more generally or uniformly used. To represent a battery of a number of cells the symbol is repeated as shown in Fig. 11.

Where two batteries, which necessarily are different in potential, are included in the same diagram, the higher potential should be shown by a greater number of the battery symbols, thus disclosing the relative potentials of the two.

Other battery symbols are shown in Fig. 12, which represents a gravity cell; Fig. 13, which represents the side of a dry cell; and Fig. 14, which represents the top view of three dry cells connected together.

In diagrams where the polarities are essential, the polarity signs, Fig. 15 for plus or positive and Fig. 16 for minus or negative should be set adjacent to the end elements of the row of battery symbols. The polarity sign alone is used often to indicate a battery, the wire stopping open, and the other battery symbols being omitted entirely. The polarity usually is indicated in wiring diagrams; seldom in skeleton diagrams unless essential.

A knowledge of the symbols thus far studied will enable the student to read a simple circuit, such as that of Fig. 17.

For ready reference to the parts of a diagram, letters or numerals are placed upon the page adjacent to the various

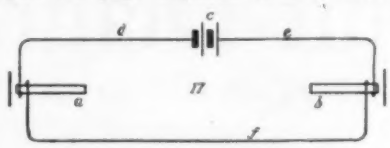


Fig. 17

elements. These are called "labels" and are used to represent the symbols in the text. Thus, in Fig. 17 there are found the telephone *a* and the telephone *b*, connected with the battery *c* by means of wires *d*, *e* and *f*. The circuit of the diagram is read, "the circuit *c*, *e*, *b*, *f*, *a*, *d*." This is Bell's original telephone circuit. The battery *c* acts through the winding of the two telephones *a* and *b* to produce the magnetic fields necessary for speech transmission and reception.

The two telephones were used both as transmitters and receivers, so that the circuit as shown is complete for talking purposes.

Transmitter Symbols

The variable-resistance transmitter has its full quota of picture symbols representing the containing case of the transmitter. Earlier transmitters had a wooden box, and from this there are the symbols of Figs. 18, 19, 20 and 21. Wires run into these symbols wherever most convenient.

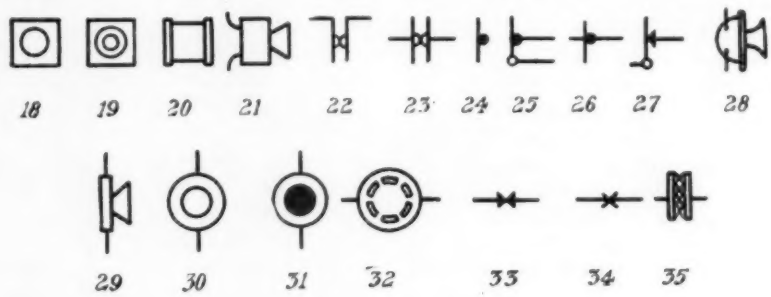
The earliest type of variable-resistance transmitter (Blake) to come into wide use comprised a single contact point (platinum against carbon) which was controlled by the diaphragm. Drawings showing the essential elements (contact and diaphragm) have made the symbols Figs. 22 to 27 inclusive. Further symbols based upon the same elements, with diaphragm omitted, are shown in Fig. 33 and 34; and multiple contact points, without diaphragm shown, are drawn in Fig. 35.

The modern transmitter case is the basis for the symbols of Figs. 28 to 31, inclusive, and Fig. 32 would be classed as a freak symbol except that it is a picture not yet reduced to a symbol. It is a full drawing of a front view of a special transmitter case manufactured for a special purpose.

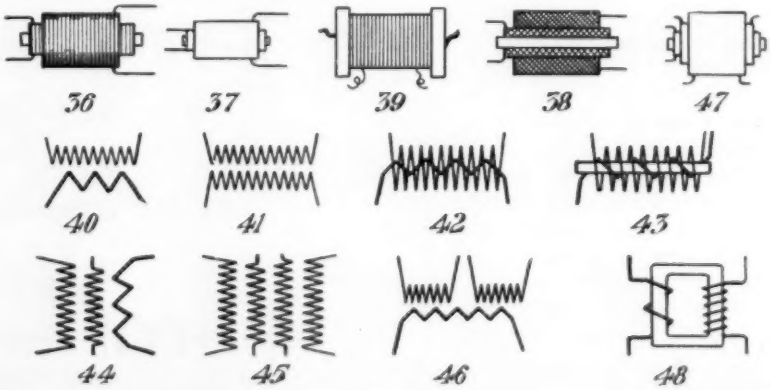
The symbols of Fig. 26, Fig. 28 and Fig. 31 are the ones most generally used.

The induction coil consists of windings of two separate wires upon the same magnetic core. Usually, one of the windings is low, compared with the other, being low both in resistance and in number of turns. The low winding usually is next to the core, and is called the primary winding; the other winding is placed upon the primary, and is called the secondary. A more efficient coil is made by winding the primary longer on the core than the secondary, with the core projecting beyond the ends of the primary; hence we have the symbols of Figs. 36, 27 and 28. The primary and secondary circuit wires may be identified by noting the identity of the winding which they enter. A sectional view is met in Fig. 38.

Fig. 39 is a literal picture of an in-



Figs. 18 *to* 35



Figs. 36 *to* 48

duction coil, showing the two square heads usually found upon such coils. The conductors entering at the ends or heads apparently pertain to the inner or primary winding, which lies next to the core, and the conductors which enter upon the surface of the helix of wire are manifestly the wires to the secondary.

The induction coil is more commonly represented by showing the windings only, as in the symbols of Figs. 40, 41 and 42. The Fig. 40 suggests an induction coil of unequal numbers of turns in the two windings, while Fig. 41 suggests equal turns; however, this indication is not followed rigidly, and the symbol of Fig. 41 is used commonly without reference to the equality or inequality of the number of turns. The use of the symbol of Fig. 40 is preferable where it is suitable.

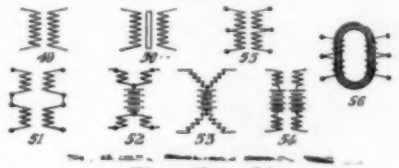
In Figs. 40 and 41, the windings are shown separated. This makes a circuit diagram easier to read, because the diagram looks less jumbled and confused. Fig. 42 shows a true relation of the two windings. Fig. 43 is a more elaborate symbol, and shows the core upon which the wires are wound, and shows also the direction of winding, which is essential in some circuits.

Induction coils frequently have more than two windings, in which case the additional windings are shown by amplifying the symbols without changing the principles of their construction. Figs. 44, 46 and 47 each show three windings. Fig. 45 shows four windings inductively related, any one of which may be the "primary" so far as the symbol goes to show. Fig. 48 typifies the toroidal induction coil.

In symbols representing induction coils having windings of widely variant turns or resistances, it is customary to show the winding of the lower resistance in a heavier line in the symbol. This is really a graphic representation of the larger diameter of wire used for winding when a lower resistance is desired. Notice the symbols of Figs. 40, 42, 43, 44, and 46, as well as Fig. 39.

To pass from the consideration of induction coils to a study of repeating coils hardly changes the subject, since the repeating coil is only a specific type of induction coil, and the same general symbols apply. A repeating coil is, by its definition, an induction coil having equal windings, so that it merely "repeats" what it receives, passing the telephonic speech currents from one of its windings to the other without changing them in any way.

The simplest symbol for the repeating coil is that of Fig. 49, which is substantially that of Fig. 41. Sometimes the core is found added, as in Fig. 50. A split repeating coil is one which has the middle points of its two windings brought to terminals accessible for the connection of external conductors. Usually it is substantially an induction coil of four equal windings. Its symbols are shown in Figs. 51 to 56.



Figs. 49 to 56

When used for feeding the current supplied from a common battery to a connecting cord pair upon the switchboard, its symbol appears as in Figs. 52 and 53. In Fig. 54, the symbol shows two batteries, independent of each other. When connecting a common battery line to a magneto line, as to a long-distance line, the battery is included in one side only of the symbol, as Fig. 54, the remaining side being bridged as in Fig. 51.

Any induction coil symbol (Figs. 36 to 48) is liable to be found, representing a repeating coil in a diagram, nor can such use be considered an abuse of the symbol.

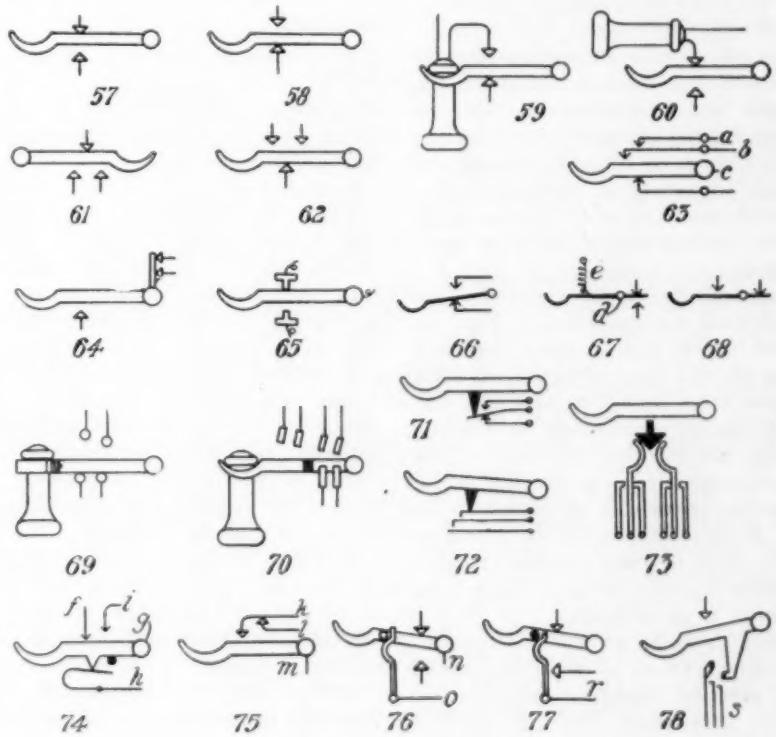
Hookswitch Symbol

The hookswitch of the substation telephone set comprises a lever, usually horizontal, pivoted at one end, with the free end projecting from the cabinet and having a hook formation to take the telephone receiver. This lever with its hook end forms a part of nearly every symbol representing a hookswitch. A spring is provided in connection with the lever for drawing the hook end upward, but this spring is seldom shown in the symbols. In association with the lever are electrical contacts, some to be opened and some to be closed as the hook end of the lever rises.

The variation in the number and location of hookswitch contacts is beyond recital. The symbols may be grouped into two classes: First, symbols of hook switches wherein the hook lever itself is one of the electrical members of the switch, or carries one of the switch members rigidly attached to it; second, those symbols of hook switches wherein the electrical switch is a group of switching springs complete in itself, and merely is operated by the hook lever mechanically, by means of the hook lever pushing or pulling upon one of the springs of the group. In skeleton diagrams, the nature of the hook switch seldom is taken into account, but in wiring diagrams it necessarily must be, since it is necessary to identify the terminals of the switch by means of the diagram.

In Figs. 57 to 78, inclusive, are shown some symbols for hook switches, and it is hoped that these typical symbols will serve to identify any hookswitch symbol which the student may encounter.

Figs. 57 to 62 show variations of the preferred symbol, and it is the symbol most generally used. The lever itself is a conductor, and it moves between fixed contact points, above and below. It will be noted that the "up" or "down" position of the hook lever may be determined only by the electrical condition of the



Figs. 57 to 78

contacts of the switch. It is convenient to draw the elever horizontal when a draftsman is working with a T-square upon a drawing board; hence the lever is horizontal, and open contacts above show that the lever is "down," while open contacts below show that the lever is "up."

Another method of showing the position of the hookswitch is to show the relative position of the receiver, whether on or off the hook, since with every hook switch there must be a receiver. Figs. 59 and 60 show this.

In Fig. 63, it is possible that some peculiarity of the circuit, of which this symbol was but a part, may have required that conductor *a* make contact electrically with conductor *b* before either *b* or *c* make contact with *a*. Or it may be merely a draftsman's preference over the symbol of Fig. 62.

Do not be deceived by variations in form, such as Fig. 64, which is exactly Fig. 62; nor Fig. 65, which is exactly Fig. 57. The Fig. 66 is just Fig. 57 drawn with fewer strokes of the pen.

The symbol of Fig. 67 shows a mechanical construction of hook lever in which the position of the pivot must be considered to determine which contacts are to be closed when the hook lever is up and when down. The contact shown electrically closed indicates that the hook lever is down; the spring at *e* is the tension spring to draw the hook lever up when the receiver is removed. This symbol is offered as an example of confusing construction which may puzzle the beginner; however, it yields to analysis and will fulfill its purpose in any circuit diagram of which it may form a part.

Figs. 68, 69 and 70 are presented as characteristic of types of hook levers and switches not frequently met, and the student is given an opportunity to analyze each of them on his own account, the analysis proceeding by determining what electrical conditions would be entailed by moving the hook end of the lever up or down.

Hook switches having contacts of the second class are presented in Figs. 71, 72 and 73. In each of these symbols a group of switching springs is mounted adjacent to the hook lever, and some sort of mechanical engagement is provided whereby the electrical conditions of the switch contacts may be changed by the upward or downward movement of the hook lever. The student is invited to analyze each of these diagrams, also to determine in each whether the hook lever, as shown, is up or down.

Special transient conditions of switching may be shown by the hook switch. Such transient conditions are met frequently in telephone practice where a temporary condition for calling the central office or signaling for disconnection is made a function of central office apparatus, and the central office apparatus then is controlled by a momentary condition set up at the substation as the hook lever passes either upward or downward.

Figs. 74 and 75 show arrangements of contact springs to give a momentary contact condition during the movement of the hook lever, which condition does not exist after the movement of the lever is completed fully.

In Fig. 74 the conductor *h* is in connection with the hook lever *g*, and as the lever moves upward it makes connection with the contact point *f*, thus connecting *g* and *h* and *f*; this connection is but temporary, since before the hook lever reaches the limit of its movement the tip of the curved spring to which conductor *h* is connected engages the black projection (black indicates insulation), and thus the spring is held back and the downward tooth upon the hook lever is permitted to move out of engagement with the spring; this breaks the connection between *h* and *f* and terminates the temporary condition. The connection with contact *i* is made also, but seems to have nothing to do with the transient condition. Upon the downward movement of the hook lever the condition is repeated, the electrical results being the same, but the contacts being made mechanically in reverse order.

In Fig. 75 hook and lever *m* engages the contact of the upper spring *k* and mechanically lifts it from the spring *l*. Electrical connection between *m* and *l* through *k* exists momentarily, and this is repeated by the reversed contacting and breaking when the hook lever moves downward.

In switches of the type of Figs. 71, 72 and 73 similar conditions of the consequent making and breaking of the switch springs may be attained in a manner which will be obvious.

Special mechanical devices forming parts of the hook switch, or associated with it, are shown in Figs. 76, 77 and 78. In Fig. 76 a pin projects from the hook lever and rubs against the vertical bent spring just below it, thus connecting conductors *n* and *o* when the hook is part way of its movement. When this symbol is a part of a complete diagram this action may be confirmed by the consideration that the circuit in which it is found requires such a condition at the hookswitch to make the other parts of the circuit diagram operative.

In Fig. 77 an insulated projection upon the hook lever presses the vertical spring to the right and against the shorter contact member, thus connecting electrically the two conductors *r*.

In Fig. 78 the three conductors *s* are connected momentarily as the hook lever passes downward, but not when it passes upward. As the hook lever passes upward the vertical spring at the left is pressed away from its two companions; as the hook lever passes downward the spring at the left is pressed toward its companions.

Where no special mechanical details or requirements of the hook mechanism are to be shown the symbols of Figs. 59 and 60 are preferable.

(To be continued.)

Stromberg - Carlson Buys Radio Station

Rochester, N. Y. — The Stromberg-Carlson Telephone Co. has taken over the ownership and operation of broadcasting station WHAM from the Rochester (N. Y.) Democrat and Chronicle and the Rochester Times-Union, former owners of this station.

Station WHAM, which is located on the top floor of the Eastman School of Music at Rochester, N. Y., opened nearly five years ago, when the two Rochester papers, each of which had been experimenting separately in broadcasting work, combined their efforts and established the 100-watt transmitter. Having access to and maintaining close relations with the Eastman School of Music and the Eastman Theater, this station has provided radio listeners of western New York state with a remarkably high grade of entertainment.

Continuance of the close relations that have existed between the station and the Eastman School of Music and Eastman Theater was a point on which the Stromberg-Carlson company was insistent before it would close the negotiations for its purchase. W. Roy McCanne, president of the Stromberg-Carlson company, hopes through the operation of the station and the cooperation of the community to give radio fans throughout a much wider range than has heretofore been possible, entertainment of the highest quality. Speaking of plans regarding the operation of the station, Mr. McCanne says:

"Our first step toward the improvement of the station will be to purchase and install a Western Electric 1,000-watt transmitter of highest audio quality and have it ready for operation on or before the opening of the School of Music next fall. As soon as the quality and power of the station have been brought up to the desired point, our effort will be to send out an increased amount of high-grade programs. This will include the broadcasting of as much more of the programs from the Eastman School of Music and the Eastman Theater as are available. It will be our aim to obtain a better and more complete chain hook-up and to enlarge our scope by bringing to our station an increased amount of programs originating in other cities, particularly events of national interest."

Radio-Wire Program Men Elect Gustafson

Chicago, Ill.—American Program Service Association, originally the Radio Program Service Association, held a permanent organization session at Hotel Sherman here, January 28 and 29 and elected the following officers: J. A. Gustafson, Fredonia, Kan., president; E. D. Glandon, Pittsfield, Ill., vice-president, and Louis Pitcher, Dixon, Ill., secretary-treasurer.

Directors, 15 in number, are: Harold L. Byer, Chicago; Frank E. Bohn, Fort Wayne, Ind.; R. S. Brewster, Lincoln, Neb.; Howard I. Crawford, Wausau, Wis.; Don Daso, Jefferson City, Mo.; W. H. Fowler, Pella, Iowa; E. D. Glandon, Pittsfield, Ill.; J. A. Gustafson, Fredonia, Kans.; Frank A. Knapp, Bellevue, Ohio; W. R. McCanne, Rochester, N. Y.; W. J. Melchers, Owasso, Mich.; Louis Pitcher, Dixon, Ill.; George B. Quatman, Sidney, Ohio; L. W. Scherer, Yale, Okla.; and Ben Woodbury, Chicago.

The executive committee consists of the president and secretary-treasurer, and E. D. Glandon, Ben Woodbury, and Frank A. Knapp. Harold L. Beyer is general counsel. The technical committee consists of R. H. Manson, Rochester, N. Y., G. R. Eaton, Chicago, and the secretary.

During the informal sessions Benjamin Olney, Stromberg-Carlson engineer, spoke on "High Quality Program Service Systems" and G. R. Eaton of Kellogg's talked on the prospective development of the service, which he believed would come from the loudspeaker. The attendants at the convention, numbering about 40, were staunch in their resolve to maintain highest standards of equipment installation.

The association's next meeting will be held during the convention of the U. S. I. T. A. at Chicago. Full details of the organization may be obtained from Louis Pitcher at Dixon, Ill.

Independents Make Buy in Minnesota

Glencoe, Minn.—A syndicate of prominent Minnesota telephone men, headed by Jay Greaves, president, McLeod County Telephone Company, and H. F. Lueders, secretary-manager of the Carver County Telephone Company, have bought the North Star Telephone Company, having exchanges at Mountain Lake and Butterfield and have negotiations pending for other properties in the state for the purpose of protecting and extending Independent operations.

Associated with Mr. Greaves and Mr. Lueders are P. M. Ferguson, manager, Mankato Citizens' Telephone Co., Mankato; Irving Todd, secretary, Hastings Telephone Co., Hastings; F. C. Marvin, secretary and manager, Zumbrota Telephone Co., Zumbrota; H. P. Sentman, manager, Fairmont Telephone Co., Fairmount; Sam A. Rask, president, Intercounty Telephone Co., operating the exchanges at Blooming Prairie, Hayfield and Ellendale; G. M. Dwelle, owner and president, Dwelle Telephone Co., Lake City.

Ralph P. Dexter Heads Stark County (Ill.) Company

Galva, Ill.—Ralph P. Dexter has been elected president and manager of the Stark County Telephone company, having secured the controlling interest in this property. A. B. Hoff of Wyoming will be secretary and assistant manager. A. J. Walters, a Wyoming banker, has been elected treasurer.

Bishop Hill, Ill.—Bishop Hill Mutual Telephone Company plans rebuilding lines.

Hillsboro, Ky.—Snickerville Telephone company plans extension of its lines.

The New York Telephone Co., Jan 26, authorized expenditure of $9,153,220 for new construction work. Of this appropriation $8,309,630 was set aside for enlargement of plant facilities in the metropolitan area.

Lexington, Ky.—Fayette Home Telephone Company executives and the Southern Bell Telephone Company, owners of 25 per cent of the purchasing syndicate, have bought Ashland (Ky.) Telephone Company and Peoples' Telephone System, Catlettsburg, Ky.

Adairville, Ky.—C. H. Moore, general manager in Kentucky of the Gainsboro Telephone Company, Cookesville, Tenn., has bought the local telephone company.

Sunbury, Pa.—Middlecreek Valley Telephone company plans rehabilitating property at approximate cost of $35,000.

Trenton, N. J.—Delaware and Atlantic T. and T. company plans to spend $2,650,000 in increasing plant this year.

Guthries Centre, Ia.—Guthrie Center Telephone company has been bought by Iowa United Telephone Company. Wilbur Shaw stays as local manager.

Odessa, Tex.—Odessa Telephone company is increasing its facilities for service.

Oklahoma City, Okla.—Sleet, and mud that mired repair trucks to the hubs, gave the Southwestern Bell's linemen here one of the worst sessions they have experienced in years around here, during the latter part of January.

Standard Underground Gets Its Eighth Grand Medal

Pittsburgh, Pa.—The Standard Underground Co., has been awarded a gold medal by the International Jury of Awards of the Sesqui-Centennial Exposition, in connection with its exhibit of bare and insulated electric wires and cables, cable terminals, junction boxes and accessories. A gold medal is the highest award in this class of exhibits.

The Standard Underground Cable Co. was one of the pioneers in the United States to manufacture lead covered underground electric cable. In 1883 its first underground cable was installed in Washington, D. C., connecting some of the Government buildings. This was a tryout of a type of cable manufactured under patents issued to Richard S. Waring, founder of the company. Since this initial installation the company has expanded its business to include not only underground electric cable but a complete line of bare and insulated electrical conductors and cable accessories of all kinds.

Pratt (Kan.) Newspaper Puts Out Edition on New Exchange Home

Pratt, Kan.—Opening of the new headquarters building of the Pratt Telephone company was commemorated in a special section of the Pratt Daily Tribune here. Details of the history and present operations of the Pratt company were profusely given. The new telephone company home was illustrated and the people who supplied equipment and furnishing for the building as well as those concerned in the planning and constructing of the building were presented with strong advertising in the special section.

Johnson City, Tenn.—Inter-Mountain Telephone company will spend approximately $150,000 in 1927 for improvements.

Decatur, Ia.—Middle States Utilities company improving its facilities in Decatur, Leon and Lamoni.

Delhi, Cal.—Delhi Community Council plans installation of local telephone system. Considering proposals from several companies.

McLemoresville, Tenn.—Charles Scott, owner of an exchange at Holly Leaf, Tenn., has moved his exchange here.

St. Louis, Mo.—W. N. Matthews corporation has issued new price lists on its products which includes Matthews anchors. The Matthews anchors price changes show a reduction in price of all sizes.

Resistance, Its Properties and Measurement

By F. J. DOMMERQUE
Fellow A. I. E. E.

46. Resistance and Conductivity

By Ohm's law the relation between the electromotive force E, the quantity of current I and the resistance R is expressed as $R = \frac{E}{I}$. This law, written in the above form, however, can only be applied to steady, non-pulsating currents. The form in which it may be applied to alternating currents will be discussed later.

Resistance is the converse of conductivity. In the same manner are "specific resistance" or "resistivity" (that is, the resistance of any particular substance as compared with the resistance of some other conducting substance such as silver, both being of unit dimensions) and "specific conductivity," reciprocal conceptions. The following table gives the relative conductivity of different substances:

Aluminum	84
Antimony	3.88
Bismuth	1.2
Brass	22
Copper	99.87
German silver	5.8
Gold	78
Graphite	0.069
Iron	16
Lead	8.88
Mercury	1.63
Nickel	7.89
Platinum	10.6
Silver	100
Tin (12% sodium)	46.9
Tin, pure	15.45
Zinc, pure	29.9

Conductivity being the reverse of resistance, the unit of conductivity has been named *"mho,"* which is the reverse of the word "ohm."

It will be noticed that copper and silver are shown of nearly equal conductivity; in practice pure copper is hardly ever met with. The commercial copper as it is found in wire contains some impurities, which make it come second in conductivity and silver first. Silver is too costly to use for wires. Copper, when "hard drawn," possesses great strength in resisting the stresses due to supporting it over long spans. When "annealed," that is, the wire is softened after drawing by heat treatment, it is suitable for coils, insulated wire, etc. Annealed wire is not as strong as hard drawn wire but its conductivity is somewhat better.

In copper wires, and for that matter in any wire used for conductors, the resistance depends on its length and diameter, besides on its material. If we designate the length by "l," the cross-section by "a" and the specific resistance by "c," we express the relation of these quantities mathematically as $R = \frac{l}{a} \times c$; which shows that the resistance is directly proportional to the length of wire or conductor and indirectly proportional to its area. We add a short table giving the specific resistance c of wire material:

	Specific resistance.	Temperature coefficient.
Aluminum, pure	0.02874	0.0037
Iron, pure	0.1042	0.0048
Iron wire	0.1324	0.0048
Copper	0.017	0.00445
Brass wire	0.0707	0.00165
Nickel	0.1306	0.00365
Silver	0.0172	0.00377
Steel wire	0.1843	0.005

The resistance of wire changes with change in temperature. The temperature for which the wire tables are prepared is as a rule 20° centigrade, which is equivalent to 68° Fahrenheit. At a temperature of 20° C., the resistance of a wire of standard annealed copper, one meter in length and of a uniform section of one square millimeter, is 1/58 ohm or 0.017241 ohm, which has been made the basis of above table.

The increase or decrease of the resistance with increasing or decreasing temperature is called "Temperature Coefficient." Metals have a positive temperature coefficient, their resistance increases with increasing temperature.

As a formula for such an increase the following may serve: Suppose a copper wire has a resistance of 5 ohm at a temperature of 20° C.; then at 50° C. its resistance will be $R_{50} - R_{20}\ (1 + At)$, where R_{50} is the resistance at 50° C.; R_{20} the resistance at 20° C.; A the temperature coefficient, whose value is given in above table, and t the increase in temperature. In the case under consideration A would be 0.00445 and t would be $50 - 20 = 30$, whence the resistance $R_{50} - 5\ (1 + At) = 5\ (1 + 0.00445 \times 30) = 5\ (1 + 0.13350) = 5 \times 1.13350 = 5.66750$ ohms.

Considering that the practical man is more used to degrees Fahrenheit than to Centigrade as used by the physicists, we will insert first the rule for transformation of Fahrenheit into Centigrade and vice versa. This rule says: To transform degrees Fahrenheit into degrees Centigrade subtract from the given number 32 and multiply the remainder by 5/9; and to transform degrees Centigrade into degrees Fahrenheit multiply the given number first by 9/5 and then add 32. Next we will add a table containing a set of coefficients so that the resistance found at a certain temperature can be calculated for any other temperature by first dividing the coefficient for the temperature at which the resistance was measured so as to reduce to 32° F., and then multiplying by the corresponding coefficient for the temperature at which the resistance is required.

TABLE OF COEFFICIENTS FOR DETERMINING CHANGE OF RESISTANCE WITH VARYING TEMPERATURE

Degrees. Fahr.	Coefficient.	Degrees Fahr.	Coefficient.
32	1.	54	1.0495
33	1.00225	55	1.05175
34	1.00450	56	1.054
35	1.00675	57	1.05625
36	1.009	58	1.0585
37	1.01125	59	1.067075
38	1.01350	60	1.063
39	1.01575	61	1.06525
40	1.01800	62	1.0675
41	1.02025	63	1.06975
42	1.02250	64	1.072
43	1.02475	65	1.07425
44	1.027	66	1.0765
45	1.02925	67	1.07875
46	1.03150	68	1.081
47	1.03375	69	1.08325
48	1.036	70	1.0855
49	1.03825	71	1.08775
50	1.0405	72	1.09
51	1.04275	73	1.09225
52	1.045	74	1.0945
53	1.04725	75	1.09675

The method of using this table is illustrated by the following example: Assuming the measurement was made for a No. 12 B. & S. gage wire (copper) having a temperature of 40° F., and it was found that the resistance was 1.56 ohms per 1,000 ft.; find in the table the coefficient corresponding to 40°, which is 1.018; divide 1.56 by 1.018, which gives 1.5324; multiply this by the coefficient corresponding to 60°, if the resistance for the wire at 60° was required, obtaining $1.5324 \times 1.063 = 1.6389$ ohms.

When two or more conductors are joined together in series, their joint resistance $R = r_1 + r_2 + \ldots\ldots + r_n$, where $r_1, r_2 \ldots\ldots r_n$ designate the individual resistances. If a current flows in a circuit containing the resistances in series, the strength of the current is the same in

*Eleventh article on Telephone Mathematics and Physics.

all parts of the circuit; it is then $I = \frac{E}{r_1 + r_2 + \ldots\ldots + r_n}$.

When two or more conductors are joined in parallel and the conductivities corresponding to $r_1, r_2, r_3 \ldots\ldots r_n$ are designated by $g_1, g_2, g_3 \ldots\ldots g_n$, then their joint conductivity $G = g_1 + g_2 + g_3 + \ldots\ldots + g_n$, and their joint resistance

$$R = \frac{1}{G} = \frac{1}{g_1 + g_2 + g_3 + \ldots\ldots + g_n} = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \ldots\ldots + \frac{1}{r_n}}.$$

For two resistances it follows $R = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2}}$; multiplying nominator and denominator by $r_2 \times r_1$, this may also be written as $\frac{r_1 \times r_2}{r_1 + r_2}$.

For three resistances in parallel $R = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}} = \frac{r_1 \times r_2 \times r_3}{r_1 \times r_2 + r_1 \times r_3 + r_2 r_3}$.

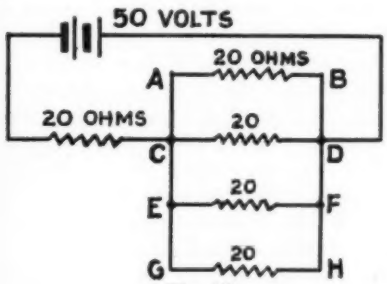


Fig. 57

As an example four resistances of 20 ohms each may be joined in parallel and with this group another resistance of 20 in series as shown in Fig. 57.* The battery in the circuit may have a pressure of 50 volts. What will be the resistance of this circuit and the current flowing in it?

Taking first the 4 resistances in parallel, we determine the resistance of that part of the circuit as follows: The conductivity of each branch $= \frac{1}{20}$ ohm; those of the 4 branches $= \frac{4}{20} = \frac{1}{5}$ ohm; whence the resistance $= \frac{1}{\frac{1}{5}} = 5$ ohms. Adding this to the 20 ohms in series, we obtain 25 ohms as the resistance of the circuit, under the supposition that the battery and connector resistance is so small as to be negligible. The current will be $\frac{E}{R} = \frac{50}{25} = 2$ amperes, that is the current in the complete circuit. The current flowing in each of the parallel branches AB, CD, EF, GH is equal to 0.5 ampere, because the resistances of the four branches are equal. If this was not the case the branch currents would be proportional to the conductivities of the branches, as will be shown in another example presently.

Plain resistances are usually indicated in drawings by a zigzag line representing a coil of resistance wire.

In a 24 volt circuit the resistances may be arranged as shown in Fig. 58. In order to determine the combined resistances from positive to negative pole of battery assuming again the connecting wires being of such low resistance as to be negligible, we take first the part with the two resistances 10 ohms and 30 ohms, and 20 ohms and 20 ohms respectively in parallel. By adding the resistances in each of the two branches, we obtain 10 ohms + 30 ohms = 40 ohms, and 20 ohms + 20 ohms = 40 ohms. The formula $R = \frac{r_1 \times r_2}{r_1 + r_2}$ gives the combined resistance, thus $R = \frac{40 \times 40}{40 + 40} = \frac{1600}{80} = 20$ ohms. To this we add the 10 ohms in series, obtaining 30 ohms. We now have again two branches in parallel, namely, this 30 ohm resistance circuit and the other 30 ohms. Applying again the formula $R = \frac{r_1 \times r_2}{r_1 + r_2}$, it results the combined resistance $\frac{30 \times 30}{30 + 30} = 15$ ohms, which is

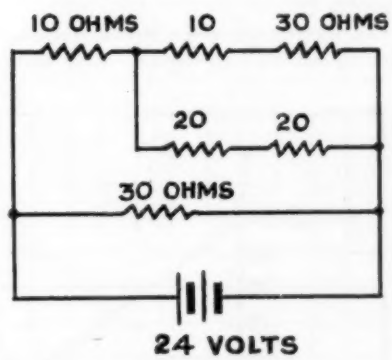


Fig. 58

the combination resistance of the circuit. Dividing 24 volts by 15 ohms the current in this circuit equals 1.6 amperes.

Here we have in the first parallel branches again equal resistances in the two branches, therefore the current divides equally between them, also in the second parallel branches.

We now will take an example where the resistances in the parallel branches are not equal. In Fig. 59 the 24 volt circuit contains two resistances of 2 and 3 ohms respectively in parallel. The combined resistance is $\frac{2 \times 3}{2 + 3} = \frac{6}{5} = 1.2$ ohms, and the current in the circuit $= \frac{E}{R} = \frac{24}{1.2} =$ 20 amperes. To determine the current flowing in each of the two branches we know that the currents are proportional to the conductivities, or we can also state this as follows: In a circuit containing two branches in parallel the currents in the two branches are indirectly proportional to the resistances of the branches. Thus in the above example the currents, which may be designated as I_1 in the 3 ohm branch and as I_2 in the 2 ohm branch, have the relation $I_1 : I_2 = 2 : 3$ or $I_1 = \frac{2}{3} I_2$.

As the current of the entire circuit is 20 amperes we know that the current I_1

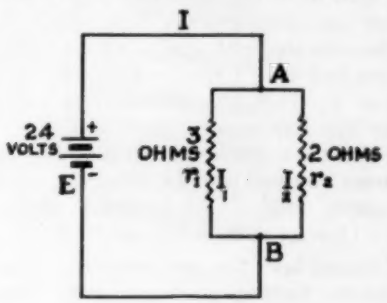


Fig. 59

must equal $20 - I_2$, because the current in the entire circuit splits up into the two currents I_1 and I_2. In the one case we have the equation $I_1 = \frac{2}{3} I_2$ and in the other case the equation $I_1 = 20 - I_2$; therefore, as the left side of each equation is I_1 in either case, the right sides must also be equal, whence $\frac{2}{3} I_2 = 20 - I_2$ or $I_2 + \frac{2}{3} I_2 = 20$, or $\frac{5}{3} I_2 = 20$, whence $I_2 = \frac{3 \times 20}{5} = 12$ amperes. As $I_1 + I_2 =$ 20 amperes, I_1 must necessarily equal $20 - 12 = 8$ amperes.

Whether there are only two parallel branches in a circuit or more of them, they can always be reduced to two branches, and then the current in each branch can be ascertained as in the foregoing example. Circuits in which the total current is subdivided in parallel branches are often called "divided" circuits. When there are two parallel branches in a circuit as in Fig. 59, the one of the branches is called a "shunt" around the other branch. This kind of shunt circuits are met with frequently in telephone work, as for instance when a relay is located in the one branch and a contact in the other branch, by which this branch can be opened and closed;

the resistance of the relay may be so fixed that when the shunt is open the relay is operated by the total current flowing through it, but will not operate when the shunt is closed because the closing of the shunt divides the current diverting the major part through the shunt.

47. Kirchhoff's Laws

First law: "If any number of conductors meet at a point, and if all the currents flowing toward the point are considered as positive, while all those flowing from the point are considered as negative, and if equilibrium exists, that is, if the electric potential at the point of junction remains steady, the algebraic sum of all currents meeting at the point will be zero."

Taking in Fig. 59 the current arriving at the point A as positive, which may be indicated by $+ I$, the two currents I_1 and I_2 must be considered as negative, because they are flowing away from point A. Then the algebraic sum of all three currents is $I + (-I_1) + (-I_2)$ or $I - I_1 - I_2$ or $I - (I_1 + I_2)$. According to above law this sum equals zero, which is correct as the example illustrated in Fig. 59 proves, because $I = 20$ amperes, $I_1 = 8$ amperes and $I_2 = 12$ amperes, whence $I - (I_1 + I_2) = 20 - 20 = 0$.

Second law: "In any network of conductors forming a closed circuit containing various currents, various resistances and various electromotive forces, the algebraic sum of all the products of the currents and resistances is equal to the sum of all the electromotive forces." Generally expressed, if the wires 1, 2, 3 ..... n form a closed circuit; if the current strength or intensity in these wires is $I_1, I_2, I_3 \ldots\ldots I_n$ respectively and if the resistance of the wires is $r_1, r_2, r_3 \ldots\ldots r_n$ respectively, the sum of the products $I_1r_1 + I_2r_2 + I_3r_3 + \ldots\ldots + I_nr_n$ must equal the sum of the electromotive forces acting in the circuit. In this connection the current strengths and electromotive forces in one and the same direction are to have the same sign, while the current strengths and electromotive forces in the opposite direction must be given the opposite sign.

Speaking of electromotive forces we must remember that there are a number of ways in which they may be produced. The most common source of energy is the battery. The e.m.f due to the ordinary battery cell is between 1 and 2 volts.

If the two poles of a battery, and for that matter of any source of electric energy, are connected by a wire, a circuit is established, wherein the e.m.f produces and maintains a current flowing not only in the external part of the circuit, i. e., the wire, but also in the internal part, the source of current. Therefore a fall of potential will take place inside this source which represents the loss due to the internal resistance and causes the voltage at the terminals of the source to be lower than the e.m.f., the greater the current consumption, the lower the terminal voltage will be. If, however, the circuit is opened, the terminal voltage will equal the e.m.f.

To illustrate this we may plot in Fig. 60 a line AB representing the resistance of the external circuit and at right angles to it a line AC representing the potential at the postive terminal of a battery, and a line BD representing the potential at the negative terminal. Then the entire potential difference is AC + BD or EC.

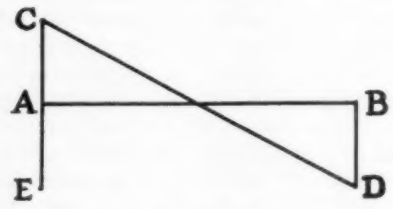


Fig. 60

This potential difference or voltage is consumed in the resistance AB; the connecting line CD graphically represents the fall of potential.

Designating by R the external resistance of the circuit, by r the resistance of the batery whose e.m.f. is E and by I the current through the battery we have the relation $RI + rI = E$. RI is the difference of potential between the terminals of the battery and by Ohm's law this difference of potential is equal to the sum of the products of the current strength and the resistance for a series of conductors forming a continuous link between the terminals of the battery.

Considering again the circuit combination shown in Fig. 59, we have three closed circuits, namely (1) the circuit from + pole of battery, over A, through resistance r_1, over B to — pole of battery, wherein we have the relation

$$I \times \frac{r_1 \times r_2}{r_1 + r_2} + I_1r_1 = E;$$ (2) the circuit

from + pole of battery, over A, through resistance r_2, over B, to — pole of battery, wherein we have the relation

$$I \times \frac{r_1 \times r_2}{r_1 + r_2} + I_2r_2 = E$$ and (3) the circuit

from A, through resistance r_1, over B, through resistance r_2 back to A, wherein we have the relation $I_1r_1 - I_2r_2 = O$.

At this juncture we may insert an example to illustrate the fall of potential in a circuit. The circuit may consist of three parts connected in series, the first part to have a resistance of 3 ohms, the second part of 4 ohms and the third part of 1 ohm. The e.m.f. impressed upon the circuit to be 24 volts. Then the current is found by Ohm's law as

$$I = \frac{24}{3 + 4 + 1} = \frac{24}{8} = 3$$ amperes. The

fall of potential in each one of the three parts of the circuit equals the resistance of each part multiplied by the current I, which gives for the first part $3 \times 3 = 9$ volts; for the second part $4 \times 3 = 12$ volts, and for the third part, $1 \times 3 = 3$ volts. In Fig. 61 are laid off the three resistances $OA = 3$ ohms, $AB = 4$ ohms and $BC = 1$ ohm along the X axis and the e.m.f. $OD = 24$ volts along the Y axis. If OD is divided into 3 parts, viz: $ED = 9$ volts, $EF = 12$ volts and $FO = 3$ volts, corresponding to the values found for the fall of potential and then horizontal lines are drawn through the points

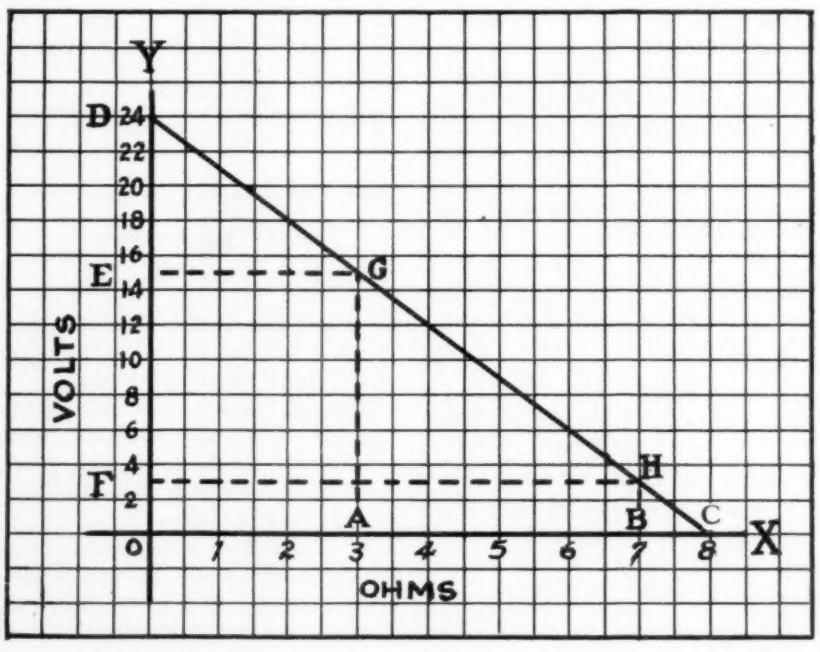
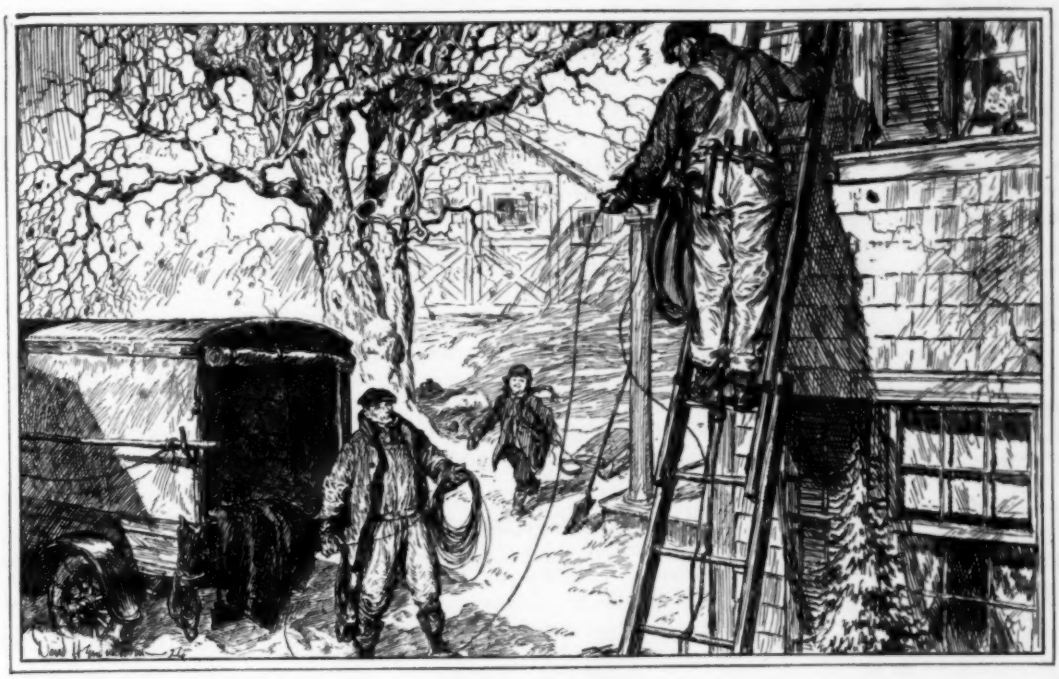


Fig. 61



Service All the Way

An Advertisement of
the American Telephone and Telegraph Company

It is impossible for a railroad train or a ship to call at the doorsteps of its passengers when they wish to take a journey. To take even a trolley or bus ride, one must go to some definite point where the conveyance stops. On the other hand, the telephone goes all the way to meet the public's convenience.

Each telephone call may be compared to a taxicab, whose destination is controlled by the subscriber. The telephone company extends its wires to the homes and offices of those who desire service, placing its telephones within immediate reach. The call is made at the time, from the point, and to the place that the subscriber desires. He speaks to the person he wants—wherever he may be.

At the disposal of each telephone subscriber are the talking channels of the entire Bell System. He may make a call a few or thousands of miles, and he may extend his voice to any point, to any person who has a telephone.

This is the essence of communication. Because of it, the number of telephones has increased in the last five years three times as fast as population. Because of it, the Bell System carries more than twenty billion messages in the course of a year.

E and F until they cut the perpendiculars (ordinates) erected in the points A and B in the points G and H respectively, the line D G H C will represent the fall of potential in the circuit, DG corresponding to the fall of potential in the 3 ohms part, GH to the fall of potential in the 4 ohms part and BC to the fall of potential in the 1 ohm part.

48. Resistance Box

In taking up resistance measurements we wish to impress it on the reader's mind that the discussion will not be devoted to the practical execution of the measurements, as the literature on that subject in TELEPHONE ENGINEER is very extensive; many papers have been written, most ably by Mr. Kerr Higgins, to which the reader is referred. Our effort here will be centered upon the explanation of the fundamental principles underlying the measurements; their application in telephone practice will not be lost sight of, however, but will be of secondary consideration here.

In all methods of measurement it is necessary to have a standard unit to compare the unknown quantity with. As a resistance standard a so-called *"resistance box"* is used, consisting of a box containing a number of German silver resistance coils connected in series; the ends of each coil are soldered to the bottom of brass blocks, the adjacent ends of the various blocks being turned out to receive a slightly tapered or conical plug, which has practically no resistance. This plug, when inserted between two blocks, short circuits the coil, the ends of which are soldered to the two blocks, thus the resistances not short circuited by plugs give the total resistance to be measured. Normally plugs are inserted between all the blocks. The brass blocks may be arranged in straight rows as shown in

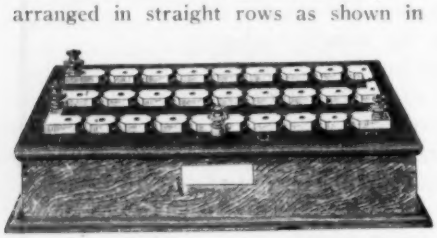


Fig. 62-A

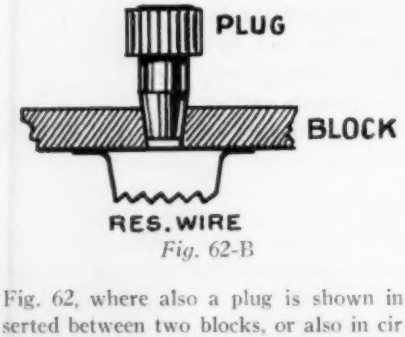


Fig. 62-B

Fig. 62, where also a plug is shown inserted between two blocks, or also in circular rows to permit of the box being made round. The round box can be operated by means of plugs or also can be arranged for switch lever operation. The coils are so arranged that either single coils or a combination of coils may be introduced into the circuit. The range of a resistance box may be in extreme cases from a hundredth of an ohm to 100,000 ohms, but the usual series of coils consists of the following number of ohm's resistance: 1, 2, 2, 5; 10, 20, 20, 50; 100, 200, 200, 500; and so on up to 10,000 ohms. By pulling out plugs in proper places any one of these can be thrown into the circuit. As an example it may be assumed the resistance under measurement had required the unplugging of the numbers 200, 50, 10, 2 and 1; then the resistance would be the sum of these numbers, namely 263 ohms.

For the purpose of ascertaining the ratio between the standard unit and the unknown quantity to be measured, it is essential, to make use of some form of indicator. In practically all electrical measurements the galvanometer is selected for this purpose.

49. Galvanometers

There exists a great variety of galvanometers according to the nature of measurements to be made: for exact measurements an instrument must permit an exact reading of the scale, that is, the scale must be subdivided into a great number of units and the instrument must be very sensitive and still work accurately and precisely. In other words, the instrument must be a precision instrument. For rough measurements, where only the ascertainment of greater or smaller quantity is required, less precise instruments will do. Of course the measurements in this case have also to be accurate, only they need not be so fine. There are different forms of galvanometers, some are better adapted for measuring resistances, some better for measuring currents; others again are of particular value for measuring capacities or inductances. Although we are at present mostly interested in galvanometers for measuring resistance, we will discuss the entire series of galvanometers so as to have a coherent record of them. As was said before, the variety of forms of galvanometers is great, but all of them are built on the principles already expounded in paragraph 29, when speaking of the tangent galvanometer. Whether the needle is deflected by the action of earth's magnetic field or by the field of a permanent magnet, whether the current flows through a stationary coil surrounding the needle or whether the coil is movable and suspended between the poles of a fixed magnet, the needle is deflected from its normal position and places itself at right angles to the lines of force due to the permanent field. The magnitude of the angle of deflection of the needle depends on the strength of the current, and the direction of the deflection, whether to the right or to the left, depends on the direction of the current.

The tangent galvanometer is in construction a rather simple affair. A heavy copper wire bent into a loop or circle of 10 to 15 inches in diameter is mounted upon a frame of wood or an insulated standard. At the center of the circle is freely suspended or supported a small magnetized steel needle (not longer than an inch) provided with a pointer. The coil of wire is placed in the magnetic meridian, when the needle will lie in the plane of the coil. The needle can rotate over a dial scale. The needle and its support are contained in a circular casing similar to the well-known compass. If it is intended to measure small currents with a tangent galvanometer, many turns of fine wire are wound upon a large wooden ring to take the place of the stout wire.

The tangent galvanometer has the advantage of simplicity, but it has a number of disadvantages, which, however, have been overcome in later types of galvanometers. In the first place, the tangent galvanometer is not very sensitive; its coil is too large in comparison to its needle, which brings them too far apart. Second, to observe the movements of its small needle it is necessary to provide it with an index; for this purpose a small but stiff pointer of aluminum had been fastened to it. In other galvanometers this has been improved upon by fastening a very small mirror to the needle, which, of course, must be light, as all moving parts in galvanometers must be made extremely light to permit almost frictionless movements. Upon this mirror is thrown a beam of light which is reflected onto a scale, which is located at some distance. Thus every slightest movement of the needle is magnified and set out clearly. This type of instrument is called a *reflecting* galvanometer. Third, the tangent galvanometer is not adapted for field work, being to cumbersome. This, however, is a property common to all galvanometers using a mirror reflection; therefore, for field work a more compact galvanometer must be used, which will be described later; at the present we will direct our attention to the type of galvanometers used for measuring in laboratories, and take up the others afterward.

The Thompson reflecting galvanometer is such a mirror galvanometer and serves for accurate work involving currents of small magnitude. Its needle is built up of several very light bar magnets arranged side by side and with opposing poles together, so that the directive influence of the earth's field shall be very slight. The needle is directly attached to a small silvered glass mirror and is suspended by a silk fiber within the coil. The magnetic field set up by the current

in the coil causes the deflection of the needle to take place. The instrument usually is made so as to permit the use of a number of interchangeable coils, so by proper calibration it may serve also as a voltmeter or as an ammeter. As the Thomson galvanometer is very sensitive to the slightest variation in the external magnetic field, and as, therefore, it is not "dead-beat," its use is also restricted to the laboratory.

In the "D'Arsonval Galvanometer," illustrated in Fig. 63, an instrument is

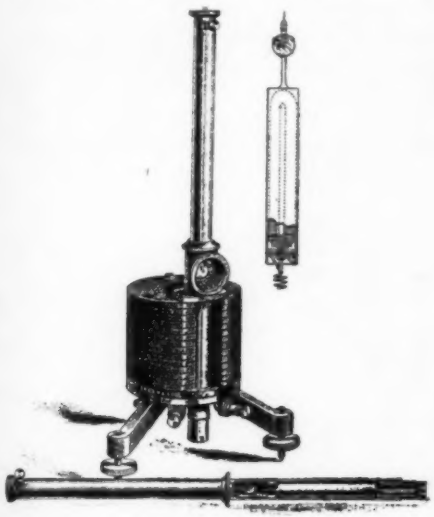


Fig. 63

obtained, which, while it lacks the extreme sensitiveness and delicacy of the Thomson, is better adapted to general practice. In this instrument the magnetic system is fixed; its poles are hollow and surround a suspended coil of very fine wire, through which the current circulates. This arrangement renders the instrument independent of any surrounding magnetic fields; when used with a short-circuiting key, it is perfectly dead-beat. The figure represents a type of an earlier make, but it shows the details of suspension lucidly.

For some measurements it is essential to employ a certain modification known as "Ballistic Galvanometer." The object of this device is to enable accurate determination of "transient" currents, that is, such currents which last only for a short while. Such currents are produced by a condenser discharge or are developed by electro-magnetic induction. As in the ballistic galvanometer the needle system will not move until the transient current has ceased to flow, the instrument measures impulses. Thomson and D'Arsonval galvanometers can be supplied with interchangeable needle systems for ballistic work. The ballistic needle often consists of a thimble- or bell-shaped magnet arranged so as to reduce the retardation of its rotation to a minimum. The relation between an electric discharge and its effect on a ballistic galvanometer is given by the following formula: $Q = \frac{TFD}{2\pi}$, where Q is the quantity of electricity in coulombs; T the time in seconds required for one complete oscillation; D the deflection with Q coulombs; F the figure of merit (the amount of current which will produce a deflection of one degree upon the scale) with a constant current.

We will mention here another galvanometer, which is of particular interest for alternating current work, but possesses some features which have not been mentioned in describing the other galvanometers. This is the Duddell Bifilar Vibration Galvanometer.* This galvanometer is adapted for the measurement

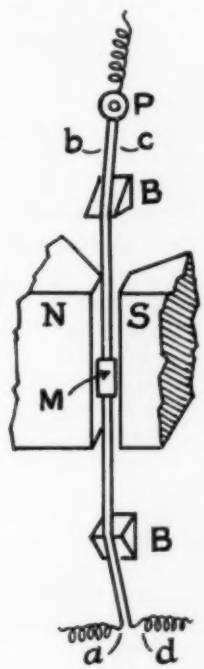


Fig. 64

of capacities and inductances and is designed so as to keep the "damping" as small as possible, as the sensibility to alternating currents depends very greatly on the magnification one can obtain by bringing the instrument into tune or resonance with the alternating current to be measured. By damping is meant means to prevent the needle from swinging to and fro for a prolonged time.

The design of the principal part of the instrument is shown diagrammatically in Fig. 64, in which a, b, c, d is a fine bronze wire starting from a, passing over a pulley P, and returning to b. It is stretched tight by means of a spring pulling on P, the tension on the spring being capable of variation by a milled head screw. The wires carrying a mirror, M, in the center d, and are placed in a strong magnetic field between the poles N and S of a magnet. The wires pass over two bridge pieces BB, which limit the length of the wires which is free to vibrate. These two bridge pieces can be moved nearer together or further apart by means of a right and left-handed screw as required. The current to be measured passes up one wire and down the other, causing one wire to tend to move forward and the other back in the magnetic field and so tilts the mirror, M, through a small angle. The periodic time of the wires depends on their mass, length and tension, as well as upon the moment of inertia of the mirror. In a completed instrument the moment of inertia of the mirror and the mass of the wires is fixed, but their length and tension can be altered in order to adjust the periodic time.

We will not go into alternating current discussions at this time, we therefore close the description of galvanometers for the present, but devote a few words to the general subject of "Galvanometer Shunts."

The deflection of a galvanometer being proportional to the current traversing its coil, and the scale being of limited extent, it frequently happens that the current is sufficient to carry the index off the scale, giving a deflection that is unreadable. It is usual in such cases to place in parallel between the terminals of the galvanometer an amount of resistance sufficient to permit of a readable deflection. Such a resistance placed in parallel with the galvanometer is called a "shunt." In Fig. 65, let G designate the galvanometer resistance, S the shunt resistance, I the total current and i and i^1 the current in the galvanometer coils and shunt respectively; then I equals $i + i^1$. The e.m.f. being the same in both

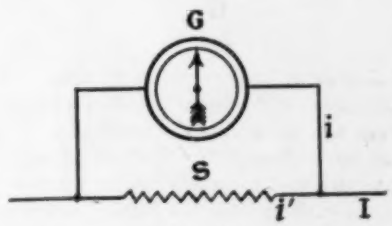


Fig. 65

branches, the respective currents will be inversely proportional to the branch resistances, that is $\frac{i^1}{i} = \frac{G}{S}$ and $i^1 = \frac{iG}{S}$, whence $I = \frac{d}{x}\frac{G+S}{S}$.

Knowing the deflection given by the galvanometer with a known current, i is easily determined; and knowing also the resistances G and S, the total current I can be calculated. The deflection that

*Proceedings Physical Society of London, May 14, 1909.

would be produced on the scale with the current I is the deflection given by i multiplied by the factor $\frac{G+S}{S}$. This factor, frequently designated by m is called the "multiplying power of the shunt." Any known resistance may be used as a shunt, though for rapid work easy multipliers should be selected.

From the value $m = \frac{G+S}{S}$ the value of S is determined as $S = \frac{G}{m-1}$. This is the amount of resistance which when placed in a shunt will give any desired multiplying power m. The best galvanometers are operated in conjunction with shunt-boxes having resistances of $\frac{1}{9}, \frac{1}{99}, \frac{1}{999}$ of the resistance of the galvanometer respectively.

50. Deflection Method of Measuring Resistance

A galvanometer of a suitable type may be connected in circuit with a battery E and a known resistance r, such as provided by a resistance box, as shown in Fig. 66. To find the value of an unknown

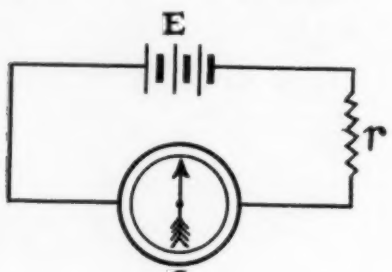


Fig. 66

resistance R it is necessary to know the resistance of the battery and the wiring. They are, as a rule, so small that they can be neglected, but for completeness sake, we will assume r^1 to be the value of the resistance of the battery and wiring combined. If we let E designate the e.m.f. of the battery and I the current in the circuit, we know by Ohm's law that

$$I = \frac{E}{G+r+r^1} \text{ or } I\,(G+r+r^1) = E.$$

With the known resistance r in circuit we obtain a deflection of the galvanometer, which we note down. We then substitute for the known resistance r the unknown resistance R and observe the deflection then obtained. With the resistance R we will obtain an expression for the current then flowing in the circuit, which current may be designated as I^1, as follows: $I^1 = \frac{E}{G+r^1+R}$ or $I^1\,(G+r^1+R) = E$, whence $R = \frac{E-(G+r^1)}{I^1}$ or $R = \frac{I\,(G+r+r^1)-(G+r^1)}{I^1}$, as $E = I\,(G+r+r^1)$ by the equation above. If d designates the deflection with the known resistance and d^1 the deflection found with the unknown resistance, the deflections d and d^1 are proportional to the currents I and I^1, that is:

$\frac{d}{d^1}$ is proportional to $\frac{I}{I^1}$. Substituting this in above expression for R we obtain

$$R = \frac{d}{d^1}\,(G+r+r^1) - (G+r^1).$$

The galvanometer resistance G is always given by the maker. If we neglect the battery and wiring resistance r^1, we have $R = \frac{d}{d^1}\,(G+r) - G$. This formula may be simplified still more by adjusting the resistance r so as to make $d^1 = 2\,d$, when $R = \frac{d}{2d}\,(G+r) - G = \frac{(G+r)-G}{2}$. When it is inconvenient to make $d^1 = 2d$, it may be made an even multiple of d.

The deflection readings in above formulae are readings in degrees, which would be acceptable, when readings are small and when no special accuracy is necessary. If this, however, is not the case, the tangent of d and the tangent of d^1 must be taken for the readings in degrees. To find their values it is essential to know the resistance of the galvanometer and of the rest of the circuit or to neglect it.

We now come to the most widely known and most important instrument for resistance determinations, the Wheatstone bridge. This deserves a discussion or rather a chapter of its own.

Lincoln (Neb.) T. and T. Head Sees Rate Peril

Lincoln, Neb.—Danger in rates that are unreasonably low considering the character of service offered were pointed out in the annual report of the Lincoln T. and T. company submitted to the stockholders' meeting here by President Frank H. Woods. The report shows that gross earnings for the year increased 4.4 per cent over 1925, but that expenses for the same period increased 6.3 per cent. The comparatively greater increase in expenses was due, primarily, to increased wages, which are of a permanent nature and necessary in order that the salary level may favorably compare with that of other industries.

The surplus revenues of the company for 1926 were $20,000 less than the year before, and it was upon this point that President Woods laid greatest stress in his address to the stockholders. He said that, considering the size of the company and the amount of its annual revenues, the amount carried to surplus is relatively small. The company, he said, had apparently not reached the place where it does set aside a comfortable margin each year.

"A public utility company," he said, "must do more than meet its requirements for operations, interest, dividends and depreciation. In addition to paying fair, reasonable wages to the men and women engaged in rendering the service, and in addition to paying fair, reasonable wages for the capital making the service possible, there must be a margin.

"This surplus is necessary to carry the company through periods of depression and to provide against contingencies, which by the exercise of the utmost care it is not humanly possible to forecast. It is essential in maintaining a financial standing that will enable the company to obtain ,on favorable terms, the additional capital which an ever-expanding industry requires. Rates not providing a reasonable surplus are, therefore, unreasonably low.

Under the customer ownership plan, which has been pushed during the year, the company sold $675,000 of the cumulative participating perferred stock, which bears 6 per cent. Employes bought 622 shares of common and 90 per cent of the employes are stockholders.

Mr. Woods said that the stability and permanence of the telephone business of the company is not threatened from any source; public relations are most satisfactory, and the general outlook for future operations is altogether encouraging

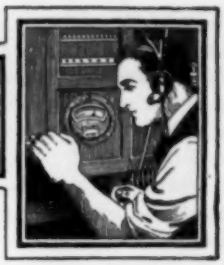
The balance sheet of the company shows these items:

Assets: Physical property, $10,343,289; investments, $451,026; material and supplies, $294,944; cash and deposits, $427,906; current receivables, $285,093. Total, $11,802,258.

Liabilities: Capital stock, $5,980,000; funded debt, bonds due 1946, $2,000,000; bills payable, none; current payables, not due, $450,180; reserve for depreciation, $2,337,961; other reserves, $139,000; surplus, $894,859.

The figures for operation show that the net earnings for the year of $656,486, as compared with the average plant, were 6.17 per cent; the average net cost to the public on the average capital invested, 6.55 per cent, and the per cent of net earnings carried to surplus, 1.09 per cent.

LINE AND DESK



MORE CONCERNING RINGING INDUCTION TROUBLE

Our call for help in last month's issue pertaining to suggestions or remedies for noise in operator's telephone circuits, due to induction from ringing current, as usual met an immediate response. One of our helpers is Ray Blain, a regular contributor to this department, who has just returned from the Philippines—where the climate is similar to that described by our querist. Mr. Blain offers the following:

"During my two years telephone experience in the Philippines, I found many similar cases of ringing induction in small switchboards, due to low insulation, caused by high humidity. To avoid this trouble it was necessary to keep one sixty C. P. carbon filament light bulb burning in each position and one or more in a cabinet covering the main frame. I never found a case where the trouble could be cleared by boiling out the induction coil, but think it might be that the paraffine was heated by an open flame near the switchboard and the small amount of heat conducted inside the board was sufficient to dry out the air and clear the trouble temporarily. If the switchboard is old, it is possible that the moisture has damaged the insulation of the wires in the cable form and the ringing leads are, of course, the first to break down. This is particularly true when the cable forms are shellaced. Cable forms for a tropical climate should not be shellaced but boiled in a mixture of beeswax and rosin."

Another contributor, W. S. Low, who is located at Coaticook, Quebec, with the Eastern Townships Telephone Co., has this suggestion to add:

"In reply to call for "Help!" on noisy switchboard—your subscriber's trouble appears to be of an intermittent nature due to induction from his source of ringing supply. You have already mentioned in your article causes as applied to the keys. There is another part of the ringing circuit which might be given attention. Most all magneto switchboards are supplied with a key to switch from power generator to hand generator. If this key is of the 3-point type, the failure of this switch to break clear of the hand generator side while in operation on the power generator or a burnt or carbonized bushing between these contacts will allow current to pass through hand generator, if it is permanently shunted. Especially, if this key wiring is run through cable running to cord circuit keys considerable induction will be set up."

A STUNT FOR LOCATING POWER LINE TROUBLE

It has occurred to me that a stunt we used to locate a ground on a power line might be of some use to others who may have the same difficulty. A group of toll lines were very noisy due to a ground on a paralleling power circuit. The power men spent some time trying to locate the ground but did not seem to be able to do much with it. One holiday they shut down the line and were testing by cutting off transformers one at a time. It occurred to me that we could use our wireless cable tester and so we connected the buzzer at one end of the bad wire. The exploring coil gave us a good tone at the next pole and so we followed the line testing at every transformer both on the line and the ground wire. We finally ran down the trouble at the end of the line at a transformer station where we found a broken down insulator. The line was a 13,000 volt line about 14 miles long. This is the only case where we have tried the stunt, but it worked perfectly in this case and we thought it might be used again if we need it. I am passing it along in case anyone else is up against the same kind of trouble. It is worth trying.—Contributed.

WHAT CAUSES THE HIGH RESISTANCE HERE?

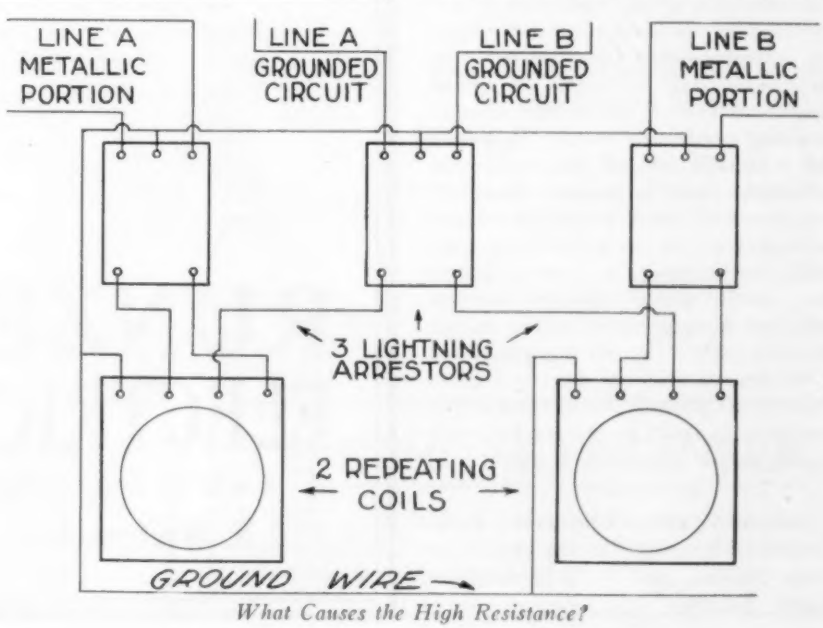
A subscriber in a western state asks for light on the following case of trouble:

"Last spring, because of trouble from power transmission lines, I made our rural grounded circuits metallic for a way and installed repeating coils, between metallic and grounded portions.

At one place I installed two coils and three arresters in one box wired as shown by accompanying diagram. The ground was very dry with a sand subsoil at that place, but with the ordinary six foot galvanized ground rod, the coils seemed to operate all right for several months. Then, one day the switchboard operator reported that the two lines seemed lightly crossed.

For testing, I have nothing more than a common bridging telephone instrument. Repeated inspections showed no visible cross. Drawing out the fuses at the coil box, left the metallic circuits to the switchboard work all right with no sign of a cross. Where the grounded portions of the two lines were on the same poles, I climbed every pole and found nothing wrong. Of course, I examined also the wires in the coil housing.

Other men seemed to think that the trouble was caused by a poor ground connection or ground. The connections,



What Causes the High Resistance?

(except at binding screws), were soldered, and we had been having rains so I did not believe that was the trouble, but I pulled out the six foot rod and drove a galvanized pipe nine and a half feet into the ground.

There was no improvement in conditions, and within about ten rods from the ground rod, an artesian well keeps water standing on the surface the year around so I can not believe yet that the trouble is caused by a poor ground. Now I have run a wire to the nearest pole and grounded one of the lines there and the lines no longer ring across.

I do not know if it would be possible for a repeating coil to go bad in such a way as to cause the trouble, but my experience here makes me suspect that such is the case.

The coils in use there are placed each in a cast iron case, the case being round and eight inches across, and four inches deep. They have been filled in with melted resin and then mounted on wooden backs. I do not know by whom made. The telephone lines are noisy yet.

At another place, in the opposite direction from town, we have also two coils, three arresters, and one ground rod installed. There has been no sign of a cross between these two lines, and one of these two lines is our nearest quiet line.

The coils there are different, each being in a cylindrical case, not much, if any, over two inches in diameter and probably six inches long. I do not know the make of them either."

Our study of the situation described does not indicate that any reason exists for the cross ringing except high resistance at some point between the place where the two coils are connected to the ground wire and the earth itself. Tests have shown that the greater part of the resistance of a ground connection is concentrated at the surface of the ground rod. Measurements have shown some surprisingly high resistances of ground connections even in places that seem to be giving satisfactory results. A ground that is suitable for one line may not be sufficiently good to prevent cross talk and sometimes cross ringing when two or more lines are connected to it. We recall one instance of two grounded lines which worked metallic through cable and were grounded at the end of the cable pairs. The soil was gravel and it was necessary to run the two lines to two separate grounds, one of them on the next pole, in order to prevent just such trouble as our subscriber is having.

Cherokee, Okla.—Cherokee Rural Telephone company incorporated by Frank Stallings and A. J. Henderson. Capital, $12,000.

L. L. Hill Elected President of Northern White Cedar Group

Minneapolis, Minn.—L. L. Hill, president of Page and Hill Co., Minneapolis, was elected president of the Northern White Cedar Association at its annual meeting here. Other officers elected were G. H. Ramsey, general manager of the National Pole and Treating Company, vice-president; George Bubar, Bell Lumber Company, and John D. Twomey, Twomey-Williams Co., directors, and N. E. Boucher, secretary. H. F. Partridge was re-elected treasurer.

T. M. Partridge, the retiring president, in his annual address spoke of the stock of short poles, including the 5-inch 25-foot size, being reduced to the minimum. There is no surplus of 30 and 35-foot poles, he stated, and this condition promises a healthy and profitable market for the northern white cedar men, unless production attains a rate much greater than now thought possible. Details of the Northern White Cedar Association's activities in connection with the American Society for Testing Material efforts to determine pole strengths, were related to the association by its representatives at the joint session, and a lively discussion was held on the subject of specifications.

Armored against the poke and pull

You can preach until doomsday about proper handling of cords and yet in the rush of peak traffic they're bound to be shamefully abused.

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A. B. Ferdinand Working Dakotas for American Electric

Chicago, Ill.—A. B. Ferdinand recently has been assigned to travel North Dakota and South Dakota as sales representative of American Electric Company, Inc.

Mr. Ferdinand began with the telephone industry in its infancy and has had

A. B. Ferdinand

experience in both the operating and manufacturing branches. A considerable part of this time has been spent in the employ of the former American Electric Company. Through his efforts telephone companies in the northwest should become even better acquainted with Monarch and American products and the service afforded by the Monarch-American combination.

Kearney Has New Solderless Telephone Connectors

St. Louis, Mo.—A single type of a solderless service connector designed especially to take the place of the three brass connectors now used for quickly disconnecting or connecting telephone service taps for No. 12 solid wire or smaller, has been placed on the market by the James R. Kearney corporation, 4224 Clayton avenue. This connector has a hexagon head bolt, either one or two washers, moon slotted, the upper washer with a tongue, and a nut. The tongue on the washer supports the sides of the slotted bolt under the nut. The connector is so designed that it cannot slacken off, its makers state.

Kearney Guy Wire Serving Clip
BRIDGING twisted pair to twisted pair, a practical application of the Kearney Solderless Service Connector.
FOR Telephone Lines in making party line taps, order Cat. Number 86. The tap can't slacken off. This connector is for No. 12 wire or smaller
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"Mack" Croswell Is American Electric Recruit

Milwaukee, Wis.—M. H. Croswell of Milwaukee has joined the American Electric Co., Inc., as Wisconsin state representative.

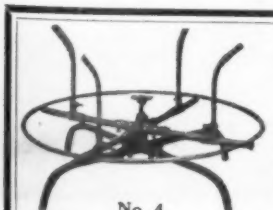
Mr. Croswell, a native of Wisconsin, is one of the old-timers in the telephone field. "Mack," as he is known to his

M. H. Croswell

many friends throughout the state, made his start as manager of the exchange at Appleton, Wis. Later he became district manager at Oshkosh. He then became interested in the sales end of the business and joined the sales force of the Western Electric company, staying with them for several years. Following this he represented the Kellogg Switchboard & Supply company for a number of years and prior to his recently made American connection was in charge of the telephone sales for the Julius Andrea & Son company of Milwaukee.

New Line Between Mexico and the United States

Mexico City, Mex.—The telephone line which the Mexican Telephone and Telegraph company is now constructing between Mexico City and Nuevo Laredo is expected to be completed before the end of 1927, thus giving Mexico City and other important points further north, telephone connection with points in the United States.



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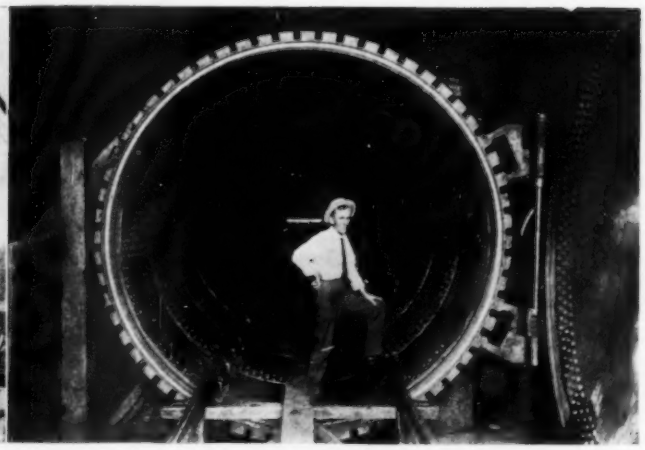
Pine Pole Treatment in Giant Plant



Left—A load of poles ready to enter the treating cylinder. Right—The largest treating cylinder in the wood preserving industry. Capacity, 80,000 ft., board measure. Diameter 9 ft. 6 in., length 165 ft.

Texarkana, Tex.—In this bustling city, representative of the new south, a constant battle is being waged particularly for telephone men and other pole and treated timber users and for the conservation of the nation's natural resources in general. At the huge 190 acre plant of the International Creosoting and Construction company, R. L. Allardyce, superintendent for the company, and his force of 500 employees are fighting the dread and destructive termites and decay fungi to the finish of those timber devouring pests, making it impossible for hungry ants to feed themselves on luscious pole lines, and mocking Father Time on two counts. The first place where the International people at this plant defy the time element is in the seasoning of poles. They have a method of seasoning without weather-

Announcing—
the Highway Earth Boring Machine
Bores the Hole--Sets the Pole
A pole in the ground every five and one-half minutes is the record recently made on new line construction—under actual operating conditions. A three-man crew with the Highway Earth Boring Machine and Pole Setter bores the holes, sets the poles and moves from position to position all in this remarkable time. A saving of 75% of the time required for the same work by any other method.
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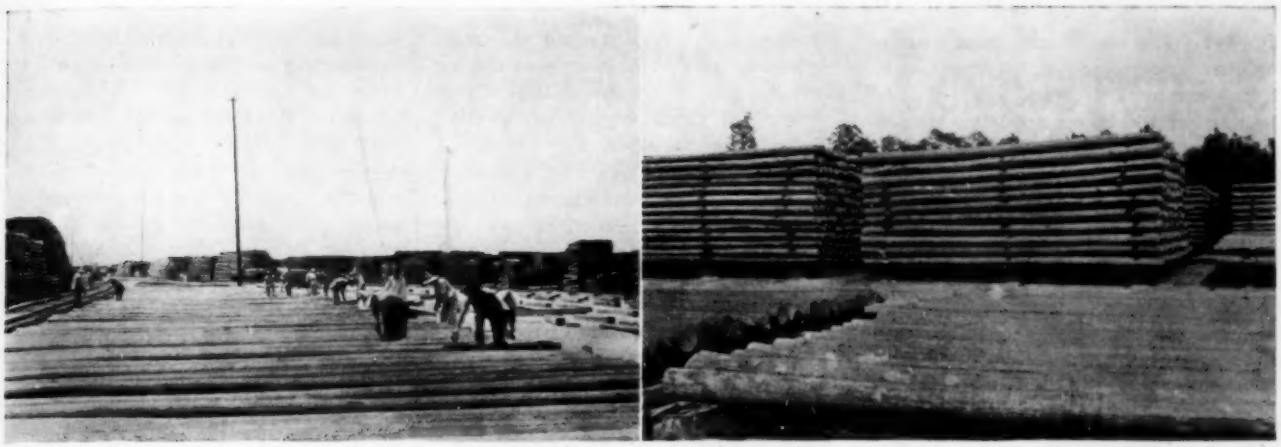

Left—The pole framing yard. Creosoted pine poles here are always framed before treatment to customers' specifications. Right—International seasoning yards have wide, straight alley-ways, assuring correct air circulation and resultant proper seasoning.

ing that cuts down the time to the minimum, and according to many pole experts, gives a better product. Then the finished product after the International treatment, instead of being a rather perishable product as it would be in the unfinished state, stands staunch and strong in the line for many years.

The plant is well located for a long time supply of the raw material. It draws its pine from a radius of between 250 and 300 miles in territory that takes in the luxuriant forests of Texas, Arkansas and Louisiana. Establishment of the International plant at that point has been a great boon to the timber men within the area of its source of raw timber supply as pine is a quick growing wood and even the small supplier with 25 acres of timber on his layout can count on years when the timber is worth from $500 to $600. Through the use of selective cutting and because of the ready reproductivity of pine, every 12 to 15 years the farmer will have a new crop ready for harvesting and treatment into splendid line materials.

So much for the source of raw timber supply. About the market; that's still an undetermined quantity growing larger at a rate even faster than the hopes of the International sales department. Right now shipments are being made in big lots by the International to the Atlantic and to the Pacific coasts.

Dates Back to 1874

This is no mushroom enterprise for the tale of treated pine poles has become one of the six best sellers with telephone men within the last decade. The company was established in 1874. Its first plant was at Beaumont, Texas. At Beaumont now there is a great treating plant operated by the company, but the Texarkana establishment is the company's biggest one. As a matter of fact it is one of the biggest general operated treating plants in the wood preserving industry. The personnel of the production organization in the forests and the plant operating personnel is trained not only to know this game of theirs from the ground up, but to exercise a watchfulness over each detail of operations that is constantly opening the eyes of the visitor. This vigilance begins right at the forest. The raw product is selected by a roving crew of experts. It's cut and then laid on creosoted timbers to keep it free from contact with any fungus growth and insects. The timber is marked at its source so if any trouble develops and is discovered at the first plant inspection, the lot may be quickly and accurately identified and the source of the trouble removed.

The plant's shipping problems are simplified by having three railroads at its service. The line of the Kansas City Southern practically cuts the yard in two. Missouri Pacific and Texas and Pacific spurs run into the plant. At this time the company is preparing considerable additional storage space for raw and treated material which when completed will total 325 acres. There's a whole lot more to this job than might be imagined off hand. All of the International plant yard space is tile-drained and is covered with a thick layer of sand. This sand blanket facilities drainage and prevents any undue growth of fungus or insect life. The International's usual precaution of doing all stacking on a base of cresoted pine timbers is maintained throughout the plant. There is a trick even to the layout of the aisles between the towering stacks of untreated and treated timbers. There must be just the right amount and character of aisle space to help circulation of air and proper weathering. International has to give this detail of operations special care for they have quite an amount of untreated material in seasoning, and treated material ready for shipment, in storage. The treated material has been worked to the design of customers prior to treatment, then treated and stored, awaiting the customers' shipping orders. The company never treats a pole and then does any cutting of gains or like operations subsequent to treatment as it will not take the risk of having any part of any of its products exposed untreated.

Some indication of the rate at which the creosoted pine pole business is growing may be had from the International's figures on the ratio of pole and tie business. Two years ago the tie business was easily the greater part of the output. Poles kept on increasing and now the plant has a 50-50 split on the poles and ties treated. Government figures covering the use of poles show twice as many creosoted pine used in 1924 as in 1923.

Creosoted Demand Heavy

Between the International's two plants they treat more than 100,000,000 board measure feet of timber a year. The Texarkana plant has had as high as 100,000 poles in the yard. A few months ago a peak of 70,000 untreated poles was laid out at Texarkana, but the vigorous work of the force soon had that vast collection cleared out and the sales department was again right on the plant's heels. This stock of poles ranges from 16 ft.-4 in. top to 100 ft.-10 in. top.

When the raw material is unloaded it comes to the adept hands of a force that trims off all the bark, frames, roots, gains and bores the timber according to the customer's order. These poles all are marked by the yard boss so the men can't go wrong on the job. Ingenious devices and the dexterity bred of long experience enable these men to prepare a pole for treatment in an amazingly short space of time. The company has two of its own locomotives that then haul the timber in big steel cages to the treating cylinders. At the Texarkana plant there are two of these treating cylinders in constant operation. One of them measures 9 ft. 6 inches in diameter and is 165

ft. long. It holds almost 6,000 cubic feet of wood. The smaller one, used mainly for rush orders, has a diameter of 6 ft. and measures in length, 125 ft. A duplicate of the larger treating cylinder is now being installed. There also is a small experimental treating cylinder. It is an exact miniature of the plant-size equipment and is used in the development and research work of the International's Department of Chemistry & Tests. New methods and new preservatives are constantly being tested in this experimental cylinder to prove or disprove their worth.

Science Controls Plant

The treating process at each of the International plants is under detailed scientific supervision. Each plant has its own laboratory and graduate chemists, with a Department of Chemistry & Tests centered at the general offices of the company in Galveston. Timber preservation is fundamentally a scientific procedure and the thoroughness of any plant's treatment is really a measure of the thoroughness of its chemical control. This company has the application of chemical and physical science in wood preservation highly developed.

The choice of the proper preservative is an exceedingly fussy job with the International people. Approximately 500,000 gallons a month of creosote oil is the quantity used at the Texarkana plant and the company's laboratory is constantly testing the material that is received. The creosote prior to acceptance, must conform to the specifications of the American Wood Preservers' Association, American Railway Engineering Association Grade 1, and American Telephone & Telegraph company. Creosote that meets these specifications is the highest quality preservative available to the treating industry.

Although International never gags at expense, the outfit doesn't overlook a chance to make all of the savings that are possible with efficient operations and complete utilization of the possibilities. For example, the extensive steam requirements of the plant are supplied by boilers burning as fuel not only the regular supply of natural gas, but the sawdust that is produced during the various sawing, boring and trimming operations. There's an almost complete absence of any sawdust refuse or vegetation, around the plant at the end of each day, for the housekeeping at this place is remarkable. The whole lot is as neat as a Dutch kitchen.

In the treating cylinders the temperature of the creosote oil is held at 180 to 190 degrees F. during the period of treatment which varies from approximately 5 hours for an air-seasoned pole charge to 16 to 18 hours for a green pole charge. The artificially seasoned poles are seasoned by saturated steam at 260 degrees F. Pressures on the treatments vary from 165 pounds to 200 or more pounds. With the treatment that International gives, the average 35 foot pole will contain about 100 pounds of creosote. The exact figure being dependent on the pole's measurements and the quantity of creosote—specified by the customer's order. One of the points that is watched carefully in this work is giving the poles treatment and seasoning that will eliminate sweating, the resulting efforts at this are creosoted pine poles that are clean and remarkably free from exuding creosote.

During the travel of the pole from the woods to the International loading, as a finished pole, there are five inspections. The first comes when the material is selected in the forest, the second as it is unloaded at the International plant, the third during the framing operation, the fourth when the pole is being sent into the treating cylinder and the final inspection as the pole is being loaded. Poles are culled for the slightest defect that would impair their serviceability as line material.

Ever since the International Texarkana plant started, it has worked on a 24 hour a day basis with very few exceptions, and then only for brief periods. To make the job attractive for the young army of employees the International maintains a clubhouse, a dining room for white and one for colored help, 26 living quarters for the white employees and 9 for the negroes. The 500 men who constitute the force all are needed and kept busy. Without the labor saving devices and the finely organized system that prevails the labor requirements of the plant would be greatly in excess of their present figure. In addition to the company's own switch engines, there are several locomotive cranes and other handling equipment. The company has its own repair shop to keep its equipment in the pink of condition. When the original plant of 10 acres was built 25 years ago quarters for the mules took up considerable space; now there isn't a mule on the lot, consequently a high moral tone prevails throughout the establishment. Even the colored help has benefited from this disassociation from the pestiferous mule, as crews of the negroes working around the layout work to the tune of camp meeting tunes rendered in chorus.

Levelland, Tex.—State Telephone company plans new building here.

Hopedale, Ill.—Telephone plants at Hopedale and Maroa have been bought by the Illinois Central Telephone company.

Telephone Mergers

THERE are many Telephone Companies in which consolidations could be effected to advantage, as thereby they would be enabled to finance extensions, make improvements, refund outstanding obligations and generally place themselves in the strongest financial position.

We are prepared to investigate the possibilities for new development, purchase or consolidation in the Independent Telephone Field, and have facilities for financing such projects as shown by our engineering and financial analyses to have warranted merit.

We shall be glad to advise with you and answer any investment questions. No fee or obligation of any sort is attached to this investigation.

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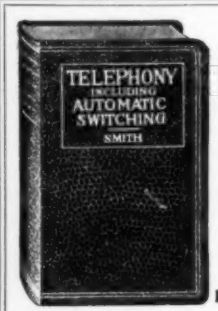

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Deerwood, Minnesota

McMinnville, Tenn.—Gainesboro Telephone company has bought the Home Telephone company of Warren County.

E. R. Sears in Kansas for Kellogg

Abilene, Kan.—Kellogg Switchboard & Supply company announces the appointment of E. R. Sears of 308 North Walnut Street, Abilene, to represent it in the state of Kansas.

Mr. Sears began his telephone career in the Plant Department of the Southwestern Bell Telephone Company in 1917 at Hutchinson, Kan. In 1920, he was made central office equipment installer for the Kansas district. In 1921, he was transferred to the Oklahoma district where he remained until the following year when he went with the United Telephone company at Abilene as installer. He held positions as wire chief at McPherson and Hayes, Kan. until 1924 when he was transferred to the general office of the United company as equipment engineer. Mr. Sears who will make his headquarters here, takes over the work formerly handled by H. J. Clark who recently left the Kellogg company to take up work in the operating field.

E. R. Sears, Representative of Kellogg Company in Kansas

West Texas Plans Big Growth in 1927

Brownwood, Tex.—West Texas Telephone company plans to spend $50,000 in expanding and improving Brownwood plant in 1927. Considerable work in central office is involved, according to F. W. Greber, general manager of company.

Stuttgart, Ark.—Southwest Telephone company has bought plants of Arkansas Telephone company. To spend approximately $15,000 in improvements.

Walnut Grove, Mo.—M. L. Grable has bought local plant from J. C. Wallen, and plans complete rebuilding.

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Mount Ayr, Ia.—J. S. Buck named manager of Ringgold County Mutual Telephone company, vice Fred Wilkinson who resigned account of poor health.

South Dakota Association Attains Majority at Biggest Meeting

Sioux Falls, S. D.—South Dakota's Telephone association became at age with the best attended convention in the entire twenty-one years of the association's history. The reason for the big attendance wasn't hard to find when one looked over the practical character of the program. The sessions were as practical and profitable in actuality as they promised to be when the forecast was held forth on the program.

Ira S. Burnette, Armour, succeeds W. W. Straight, Crooks, as president of the association. Other officers elected were Grant E. Preston, Hitchcock, vice president; and Thos. Phalen, Aberdeen, sec.-treas. The executive committee consists of Gust Quast, Benno; M. E. Guinter, Sioux Falls; W. W. Straight, Crooks, and O. E. Fauske, Brandon.

South Dakota's finances are in fine shape and the association derived considerable good from the district meetings held last year. It is expected that the association will intensify its district efforts next year as a result of the recommendations in retiring president Straight's annual address.

Echoes of the district conferences were heard in the address made by L. F. Wood, division transmission engineer of the Northwestern Bell Telephone company when he talked on inductive interference. Mr. Wood went into details of construction and in blackboard work presented some solutions for interference problems. At the conclusion of his remarks there was a lively discussion.

Tribute was paid to association work by J. J. Murphy of the South Dakota Railroad commission. He commented on the association members reports to the commission being much better than the reports submitted by the non-association members, and he added that the association members reports were put in on time.

"Exchange construction" was the subject of the address made by Oscar A. Knell, plant superintendent of the Tri-State. He counseled building with a view of expansion. Se stated that rates based on valuations should be high enough to allow for 5 per cent depreciation and 7 per cent on the investment. With construction costs higher than several years ago rates now would have to be higher to allow the proper return. He detailed various phases of construction in a manner that proved highly interesting to his audience.

The traffic problem, according to W. F. Cozad, general superintendent of traffic for the Northwestern Bell, who spoke on this subject, is divided into three parts; the personnel of the organization, training the employees selected and the methods to be employed. He outlined a program for correctly covering these three phases of the problem. "Operating the Small Exchange" was the topic assigned to W. J. Brazell, general manager of the Dakota Central Telephone company. There was much useful material in Mr. Brazell's address, which was typical of the brass-tack character of the entire program. George Gantner of Lynton T. Block and company talked on "Casualty Insurance—Its Service to the Telephone Field" and during the course of his remarks pointed out many risks that telephone companies would be relieved from by proper insurance protection.

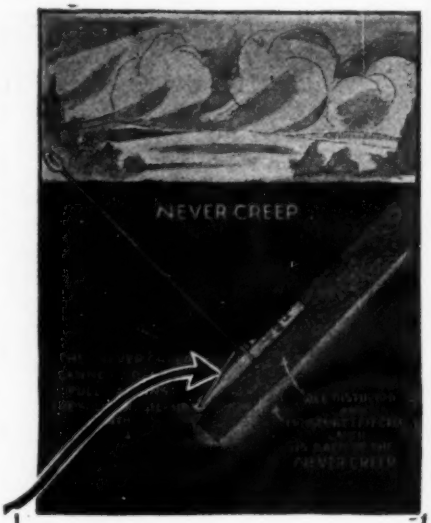
C. A. Camp, Independent Vet, Dies at Peoria, Ill.

Peoria, Ill.—C. A. Camp, of Henry, Ill., one of the Independent telephone pioneers of the state, died at the Methodist hospital here, January 16, age 70, following a prolonged illness.

In 1897 Mr. Camp started in the telephone business at Henry and became associated with the late E. S. Sterrett in forming what later became known as the Henry County Telephone Company. October 1, 1926, he sold his half interest in the Henry County company to Joseph H. Benefiel. He retained his interest in the Cheadle-Starrett properties. Mr. Camp was one of the best known and best liked telephone men in his state and enjoyed the highest standing in his home community. Throngs from his home town as well as from distant points who attended his funeral gave evidence of the warm esteem in which he was held. He is survived by his widow, Ella S., and by one sister.

Dr. W. L. Moor, Florida Executive, Dies

Tallahassee, Fla.—Dr. Wm. Louis Moor, president of the Southern Telephone & Construction Co. and vice-president of the Florida Telephone Association, died here January 15, age 74. Dr. Moor helped organize the company in Tallahassee in 1895 and was president of the company from the time of its incorporation until his death. He was prominent in state and national telephone association work and was a leading figure in the social, business and political life of his native city, having served two terms as mayor.



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